Agriculture Canada

SOILS OF CUMBERLAND COUNTY NOVA SCOTIA

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Canada Department of Agriculture

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PREFACE

This report and the accompanying soil map present the findings of a soil survey of Cumberland County conducted from 1966 to 1969. The County was surveyed previously (36) and a map was produced on a scale of 1 inch to 2 miles.

The larger scale of the new map, 1 inch to 1 mile, permits presentation of the soils in greater detail. A few of the original soil groupings have been discarded, and the basic mapping units, soil associations, have been subdivided into soil series on the basis of soil drainage. Each soil series is identified on the map by colors and symbols and is further subdivided into phases of differing slope and stoniness; this information was not on the previous map.

The report begins with a discussion of the geographical setting of the soils, climate, geology, landforms, vegetation, and a brief economic history of the area. There follows an explanation of how the soils were distinguished and mapped and an account of the characteristics of each of the 29 soils and land types on the map.

A chapter on land use follows, which includes recent farming trends, farm and forest production, the rated capability of the various soils to support agriculture and forestry, and their limiting factors. A section on the engineering aspects of the soils is included.

Part II of the report contains more technical material for those interested in the development of the soils and the basis of their classification in a wider context. A detailed profile description representative of each soil is provided, followed by comments on the significance of some of the analytical data. The general analytical and engineering data are given in a separate appendix in the pocket of the back cover.

Soil science terms used in the report are defined and explained in a glossary.

If you wish to obtain information about the soil in a given area, locate the area on the map and identify the soil in the legend. Some basic information is given in the map legend, but refer to the report for full information, because soil is infinitely variable in most characteristics.

If features observed in the field do not fit the description of the soil and its range of characteristics in the report, often the soil observed covers an area too narrow to delineate on the map. The soil can usually be identified by reference to the associated soils mentioned in the account of each soil series.

SUMMARY

Cumberland County covers just over 1 million acres of land in northwestern Nova Scotia with shorelines on the Bay of Fundy and the Gulf of St. Lawrence. The climate is characterized by mean temperatures for January and July of 20 F and 65 F, an annual precipitation of 39 to 47 inches, and 60 to 80 inches of snowfall. Fifteen inches of rain falls in the growing season when evapotranspiration is 17 inches. The frost-free period ranges from 100 to 140 days. The mean annual soil temperature at a 20-inch depth is between 42 and 47 F.

The east–west range of the Cobequid Mountains, rising to 1,000 ft, separates a broad, undulating to rolling till plain in the north from the narrow littoral in the south. Areas of reclaimed salt marsh fringe the Cumberland Basin arm of the Bay of Fundy. The forests, which cover 80% of the area, have been heavily exploited and their present composition is 40% softwoods, 23% hardwoods, and 31% mixed woods.

The soils were mapped on a semidetailed scale in agricultural areas and a

reconnaissance level in the forests; the mapping units are based upon the soil series. The 1 inch to 1 mile map in three sheets, which accompanies the report, shows the distribution of 29 soil series and land types, separated into numerous slope and stoniness phases.

The chief agricultural soils belong to the Tormentine, Pugwash, Debert, Cumberland, Acadia, Hansford, and Queens series. Most commercial farming is presently concentrated on the Tormentine, Pugwash, Debert, and Cumberland soils.

Dairy products and small fruits are equally important sources of farm revenue, followed closely by cattle and hogs. These account for 70% of the total farm income; sales of eggs and greenhouse products produce a further 20%. In 1966, 64 farms had sales worth more than $10,000 and the area contained 66,500 acres of improved land. The annual production of forest products, sawn and round, averages 6.5 million ft^3 of softwood and under 400,000 ft^3 of hardwood.

In the soil capability classification for agriculture of the Canada Land Inventory, 23% of the land area is in Classes 2 and 3, soils suitable for sustained arable culture. Fifty percent of the soils are in Class 7, with no capability for either arable or permanent pasture.

In the land capability classification for forestry, 0.5% of the area is in Class 3, 40% in Class 4, and 50% in Class 5. Dense subsoil is a major limitation in conjunction with regional limitations of climate and fertility.

For civil engineering purposes, attention has been focussed on material below the solum and the 19 soil series on glacial till have been reduced to eight groups. Many of the soils can be described as dense, with low water content, high shear resistance, and low compressibility. The four groups of water-laid deposits are less dense and vary greatly in grain size and strength within conventional mapping units. The County has valuable gravel deposits in and around the Cobequid Mountains. In rating the soils for off-road trafficability, the density of many of the tills is significant.

In Part II the origin and development of the soils are discussed in the light of the factors of soil formation and soil classification. Podzols occupy 57% of the area, Brunisols 17%, Gleysols 10%, Luvisols 10%, and Regosols 2%. Soils developed upon glacial till cover 91% of the area and 60% of them are well drained, 28% imperfectly drained, and 12% poorly drained.

Profiles representing each of the soil series are described in detail. Analyses disclose that almost all the undisturbed surface soils are very strongly acid and the pH generally rises markedly with depth. The organic matter levels are relatively low; the accumulation of mobile Fe and Al in the B horizon depends upon good drainage; and the cation-exchange capacities are generally low and, in the upper sola, base unsaturated.

PART I

GENERAL DESCRIPTION OF THE AREA

Location and Extent

Cumberland County is situated in northwestern Nova Scotia between latitudes 46° 00′ and 45° 18′ and between longitudes 63° 14′ and 64° 57′. It is bounded by Colchester County to the south and east and adjoins the province of New Brunswick through Chignecto Isthmus in the northwest. There are approximately 50 miles of coastline on Northumberland Strait in the north and twice this length along Chignecto Bay, Minas Basin, and Minas Channel, all arms of the Bay of Fundy.

The County covers 1646 square miles, or 1,053,537 acres.

Climate

The County lies within the cool, humid, temperate climatic zone where the weather displays great variability at all seasons. This variability is produced by continual interaction of continental and maritime air masses and, because most of the weather systems originate in the interior, the continental influence often dominates the marine influence. The mean annual temperature range in the County is double that on the Pacific coast. Continental influence is felt in the warm anticyclonic spells in summer and the cold clear periods in winter. Winters are cold with frequent snowfalls; forage and fall grain crops are often winterkilled. Springs are

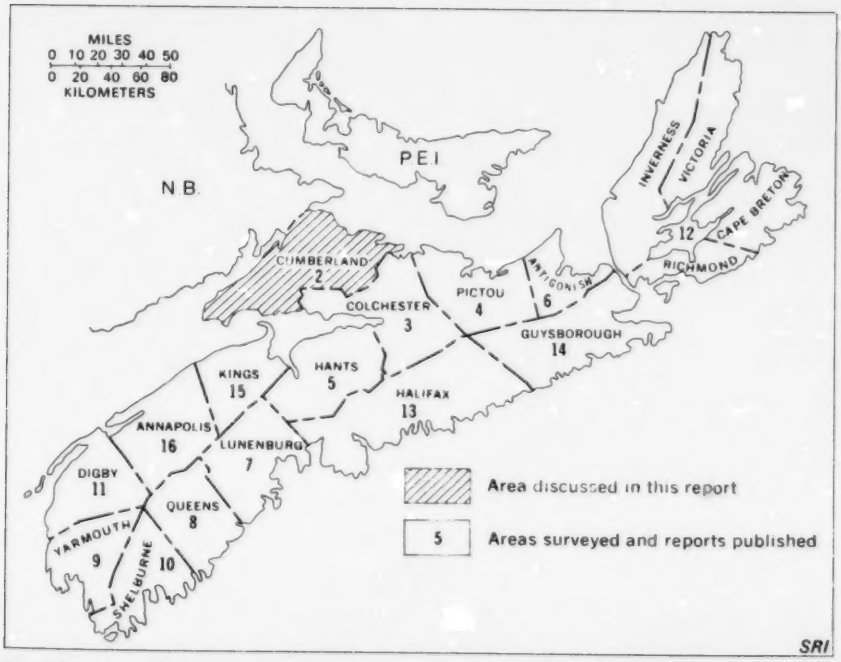

Fig. 1. Location of Cumberland County and areas of Nova Scotia previously surveyed.

late, cool, and cloudy, and summers are warm and quite humid. Rainfall is greatest during the fall months.

The climatic data for Nappan are fairly representative of the low-lying north shore and Cumberland Plain; Parrsboro is typical of the Fundy coastal plain (Table 1).

Annual precipitation is 39 to 42 inches on the Cumberland Plain and up to 47 inches on the Minas Basin shore in the south. Average snowfall amounts to between 60 and 80 inches a year and commonly covers fields to a depth of 12 to 18 inches in midwinter. Mean July temperatures are 64 to 65 F and January temperatures range from 19 F and lower on the Cumberland Plain to 21 F at Parrsboro. Extremes of temperature are not excessive; the lowest monthly average of mean daily minimum temperatures is 9.8 F at Nappan and 11.9 F at Parrsboro, whereas the highest monthly average of the daily maximums are 75.3 F and 74.4 F respectively. The average annual soil temperature at a depth of 20 inches is 42–47 F.

Fogs are common along the Fundy coastal area during all seasons, but the Northumberland shore is much less affected. The coastal areas take the brunt of the winds, which are commonly from the west and northwest in winter. Northwesterlies in spring are frequently responsible for delayed plant growth along the Northumberland shore, and all year they are often twice as strong on the shore as at points inland.

A rough estimate of the moisture available for plant growth can be made from the precipitation figures and moisture losses by evaporation and transpiration by plants. Total potential evapotranspiration for the plant-growing season (May to September) is 17 inches of water, 2 inches more than the rainfall. In average years, water stored in the soil at the beginning of the season supplies the difference, but the loose coarser-textured soils, which have a low water-holding capacity, suffer moisture deficiencies in middle and late summer. As an aid to agricultural and irrigation planning, risk analyses of the weekly climatic data for Nappan have been prepared by the Plant Research Institute, Ottawa (13). They permit prediction of the probability of crop damage due to moisture deficiency and indicate the timing of irrigation on a weekly basis.

An indication of the length of the growing season for most crops is given by the average number of degree-days above 42 F; in the surveyed area they total 2,500 to 2,600, which is comparable with the Prairies but 1,000 degree-days fewer than in southern Ontario. Using a higher threshold for corn requirements, an average of 1,900 to 2,100 corn heat units are accumulated on the lowlands.

For practical purposes, the length of the growing season is governed by the occurrence of the latest spring frost and the earliest fall frost. Their average and extreme dates and the average frost-free period are shown in Table 2. The frost-free period varies from 110 to 140 days at different locations, and it is curious that the inland site of Springhill has the longest period (140 days), whereas the coastal site at Parrsboro has only 111 days. This anomaly may be due to the exceptionally good air drainage at Springhill's elevated site.

In Table 3 frost data for Nappan and Parrsboro are expanded to show the calculated probability of occurrence of frost after certain dates in the spring and before certain dates in the fall.

The depth to which frost penetrates in the soil and its duration depend upon the amount and duration of snow cover, the texture and moisture content of the soil, and the type of vegetative cover. Well-drained forested soils may freeze to only a few inches under substantial snow, or up to 3 ft when seasonal snowfall is well

Table 1. Monthly temperature and precipitation data for representative stations

Element	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
						Nappan							
Mean daily temp (F)	19.1	19.0	27.3	38.7	49.3	58.2	64.8	63.6	56.7	46.7	37.0	24.1	42.0
Mean daily max temp	27.9	28.1	35.3	47.0	59.4	68.3	75.3	74.3	66.7	55.7	44.0	31.7	51.1
Mean daily min temp	10.3	9.8	19.2	30.3	39.1	48.0	54.2	52.9	46.7	37.6	29.9	16.4	32.9
Maximum temp	57	59	66	79	84	89	90	94	90	80	70	63	94
Minimum temp	-34	-35	-21	-6	20	26	33	32	25	10	-2	-24	-35
Mean rainfall (inches)	1.83	1.43	1.54	2.14	2.73	2.89	2.57	3.28	3.73	3.50	3.94	2.11	31.69
Mean snowfall	20.3	18.9	14.5	5.9	0.1	0.0	0.0	0.0	0.0	0.6	5.1	16.4	81.8
Mean total precipitation	3.86	3.32	2.99	2.73	2.74	2.89	2.57	3.28	3.73	3.56	4.45	3.75	39.87
Days with measurable rain	6	5	8	10	12	11	10	11	10	12	13	8	116
Days with measurable snow	9	9	7	3							2	7	37
Days with measurable precipitation	14	12	13	12	12	11	10	11	10	12	15	14	146
Maximum precipitation in 24 hr	2.71	3.30	1.80	1.50	1.70	2.03	2.25	3.27	6.05	3.28	2.75	1.48	6.05
						Parrsboro							
Mean daily temp (F)	21.0	21.2	29.2	39.7	49.5	58.0	64.3	63.6	57.2	47.7	38.3	25.6	42.9
Mean daily max temp	30.1	30.0	37.5	48.6	59.8	68.6	75.4	73.9	67.4	57.0	46.1	34.2	52.4
Mean daily min temp	11.9	12.3	20.8	30.7	39.1	47.4	53.2	53.3	47.0	38.4	30.5	17.0	33.4
Maximum temp	58	58	68	81	86	89	92	92	85	74	70	66	92
Minimum temp	-32	-31	-17	-11	15	26	31	25	22	11	-10	-25	-32
Mean rainfall (inches)	3.02	2.45	2.69	3.17	3.46	3.35	2.93	3.96	4.17	4.01	4.45	3.23	40.89
Mean snowfall	15.8	15.5	11.9	4.4	T	0.0	0.0	0.0	0.0	0.4	2.7	11.2	61.9
Mean total precipitation	4.60	4.00	3.88	3.61	3.46	3.35	2.93	3.96	4.17	4.05	4.72	4.35	47.08
Days with measurable rain	5	4	5	8	9	8	7	7	7	8	9	5	82
Days with measurable snow	6	5	4	2							1	4	22
Days with measurable precipitation	9	8	8	8	9	8	7	7	7	8	10	9	98
Maximum precipitation in 24 hr	4.90	3.20	2.00	1.95	3.18	1.70	3.13	3.85	2.60	6.01	3.13	2.50	6.01

Data from Temperature and Precipitation Tables for Atlantic Provinces, Vol. IV, Meteorological Branch, Department of Transport, Toronto, 1967.

T trace

Table 2. Average and extreme dates of frost and length of frost-free period at representative stations

Station	Elevation	Last frost in spring			Average frost-free period, days	First frost in fall		
	ft	earliest	average	latest		earliest	average	latest
Sackville, N.B.	24	May 3	May 19	June 7	132	Sept. 8	Sept. 28	Oct. 18
Nappan	28	May 8	May 28	June 21	115	Aug. 27	Sept. 20	Oct. 16
Parrsboro	40	May 12	June 1	June 21	111	Aug. 1	Sept. 20	Oct. 21
Springhill	600	May 10	May 21	May 30	140	Sept. 21	Oct. 8	Oct. 31
Advocate		May 22	May 31	June 6	121	Sept. 8	Sept. 29	Oct. 16

Information taken from Climatic Summaries, Vol. III, Meteorological Branch, Department of Transport, Toronto, 1956.

Table 3. Probability of frost occurrence at representative stations

	Probability of last spring frost occurring on or after dates indicated				Probability of first fall frost occurring on or before dates indicated			
	3 yr in 4	1 in 2	1 in 4	1 in 10	1 in 10	1 in 4	1 in 2	3 in 4
Nappan	May 19	May 28	June 6	June 13	Sept. 7	Sept. 13	Sept. 20	Sept. 27
Parrsboro	May 24	June 1	June 10	June 18	Sept. 6	Sept. 13	Sept. 20	Sept. 29

Information taken from Climatic Summaries, Vol III, Meteorological Branch, Department of Transport, Toronto, 1956.

below average. Freezing is largely confined to the litter layer in poorly drained forested soils under average snowfall, but they can freeze at a 12-inch depth for several weeks when snow cover is thin and intermittent. In cultivated soils frost may persist for 3 to 5 months in the plow layer. At a depth of 20 inches, it may last for only 1 month in poorly drained soils beneath deep snow, or 4 months in soils that are well drained and exposed.

For more detailed information on the climate and its agricultural aspects refer to the numbers 12, 13, 20, and 21 in the list of references.

Physiography and Geology

Cumberland County can be divided into three distinct physiographic units: the east-west range of the Cobequid Mountains separates two areas of lowland, the broad Cumberland Plain to the north, which occupies three-quarters of the County, and the narrow Minas Basin littoral to the south. On the physiographic map of Canada (15), the Cumberland Plain falls into the Maritime Plain and the rest of the County is in the Nova Scotia Highlands.

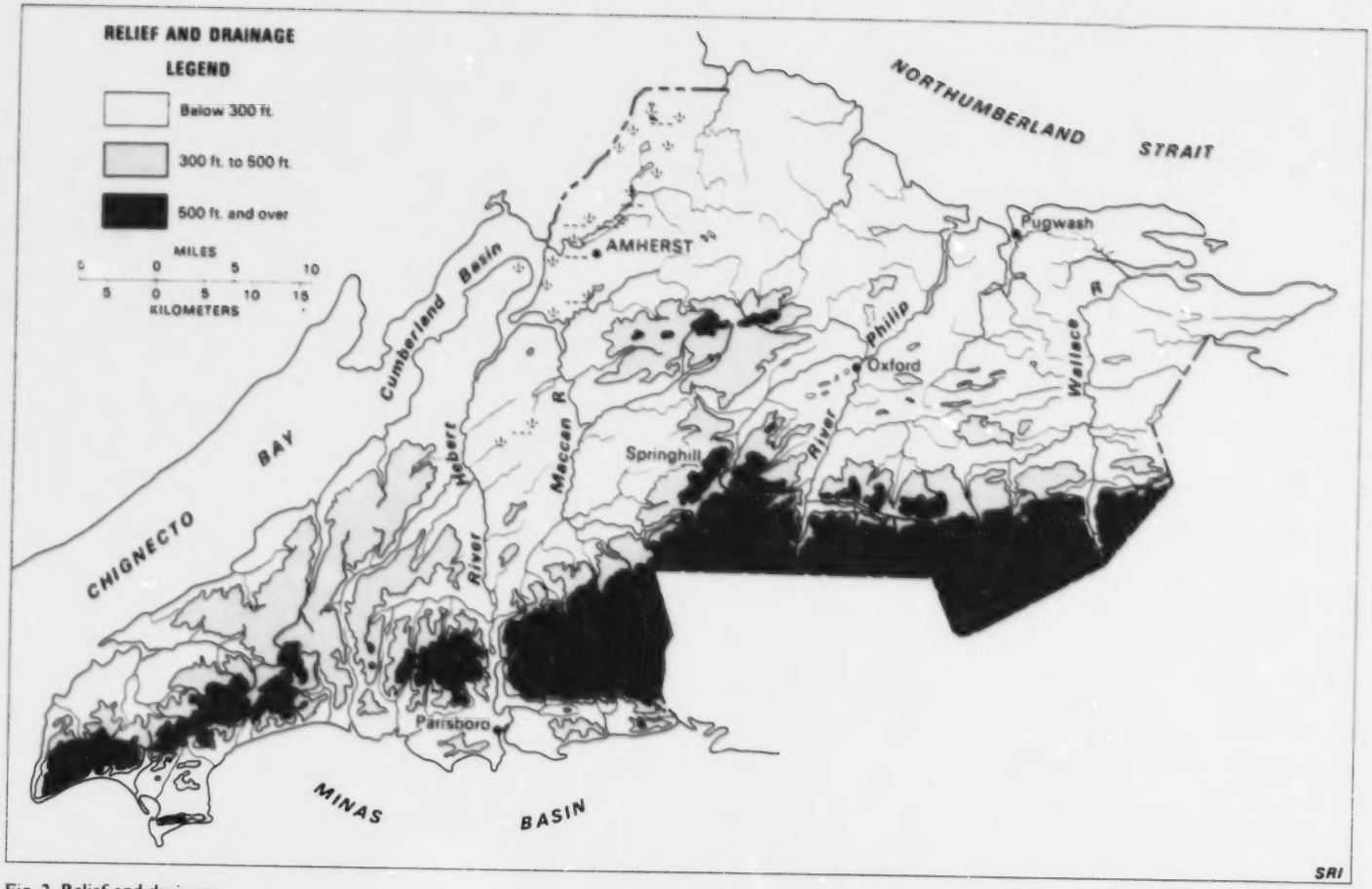

Fig. 2. Relief and drainage.

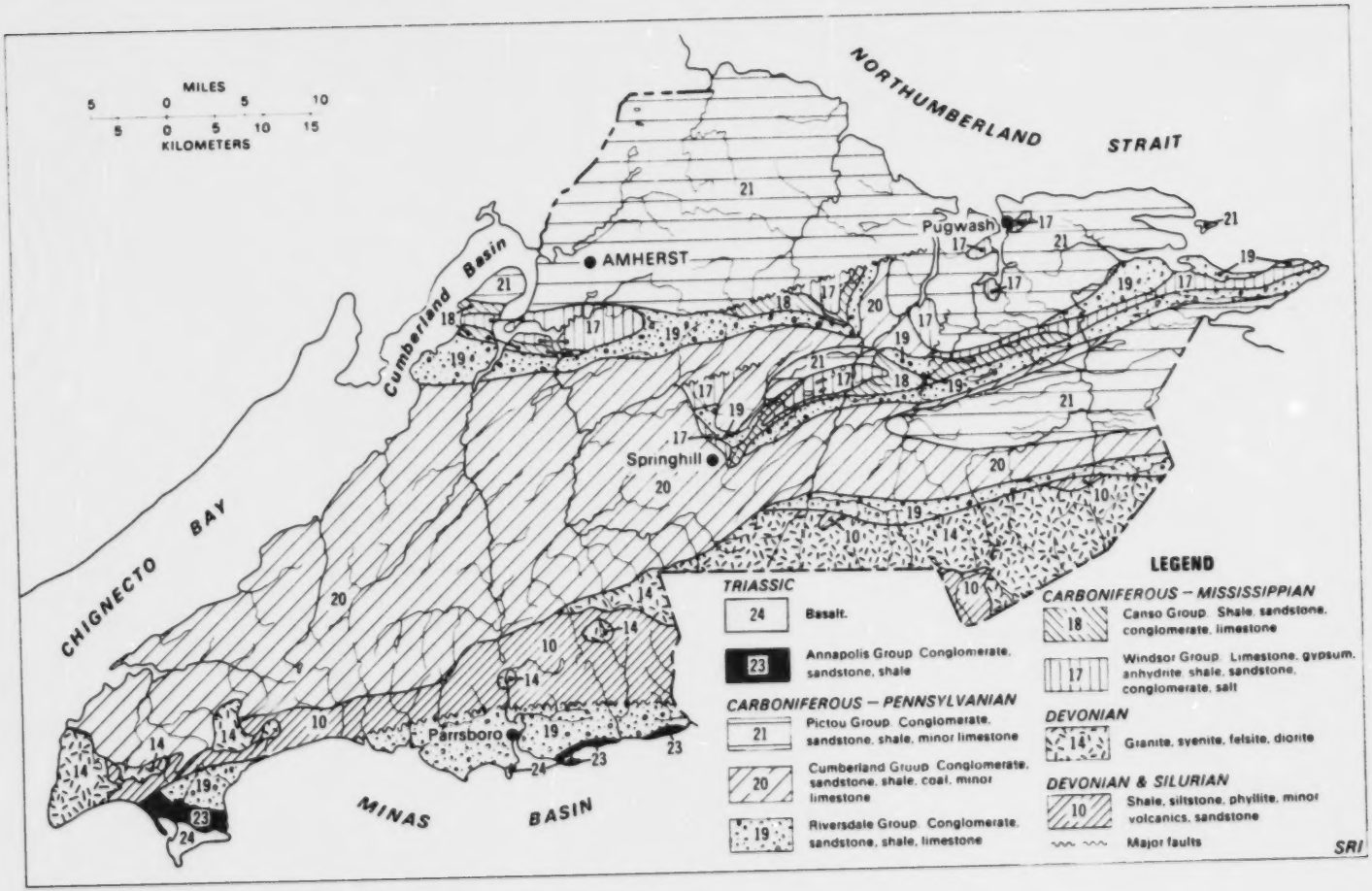

Fig. 3. Geological formations.

Cobequid Mountains

The long low range of the Cobequid Mountains forms a substantial barrier 8 to 10 miles wide across the south of the County. It is a remnant of the ancient Atlantic peneplain, and forms a narrow plateau with a rolling summit level 850 to 1,000 ft above sea level. The highest point, west of the Wentworth Valley, is at 1,100 ft. The steepest slopes occur around the deeply dissected periphery, which is formed on the south side of the mountains by an east-west fault escarpment.

The prominence of the Cobequid range results from the resistance of its crystalline and metamorphic rocks to the denudation that produced the plain to the north and the Minas Basin to the south. It is a detached block of the pre-Carboniferous Meguma platform, which forms the core of the province, and it lies within the Fundy geosynclinal basin in which was laid the Carboniferous beds. The block is composed of Lower Devonian and older sedimentary and minor volcanic rocks, which were intensely folded and to a large extent metamorphosed, and then intruded by a mid-Devonian granite batholith.

The range is traversed by two main passes, one at Folly Lake with a summit height of 600 ft and the other north of Parrsboro at no more than 85 ft above sea level. Both are of fairly uniform width throughout and are occupied by notably undersized streams. They owe their origin to old antecedent rivers, possibly rising far to the north, and were deepened by glacial ice and meltwaters.

Glaciofluvial sands occupy the valley floor of the Parrsboro Gap and have been extensively reworked by postglacial streams. Lateral and terminal moraines occur in the valley north of Parrsboro. A large outwash gravel fan radiates from the south end of the Parrsboro Valley and an equally remarkable esker, the Boar's Back, extends 7 miles from the north end.

The summit of the higher Folly Lake pass is plugged with glaciofluvial gravels, behind which the lake itself has accumulated. The northerly exit from the pass is by way of the scenic Wentworth Valley, a steep-sided 600-ft trough, floored by glaciofluvial gravels that merge into outwash sands.

This pattern of piedmont glaciofluvial sand and gravel deposits reappears wherever valleys and ravines in the Cobequid Mountains debouch to the lowlands. The mountains themselves are covered with a very thin mantle of stony till, which is of limited local origin, and has a gravelly sandy loam or loam texture and olive color. Prest and Grant (30) believed the last ice sheet receded fairly evenly northward, leaving no residual ice on the hills, but the extensive glaciofluvial deposits north of the mountains appear to have originated in northward-flowing meltwater.

Cumberland Plain

The descent from the northerly slopes of the Cobequids into the Carboniferous structural basin of the Cumberland Plain is quite gradual in the west. It is much steeper east of the Maccan River where a long east-west piedmont trough has been excavated in softer rocks adjacent to the granite hills. A series of such east-west depressions, which are generally poorly drained, and intervening parallel ridges dominate the scenery of much of the Cumberland Plain; they reflect the alignment of the main folds of the Carboniferous strata, with harder sandstones and conglomerates forming the ridges. Some of the ridges, such as those at Springhill, Salem, and Claremont, rise 200 to 300 ft above the general 200-ft level of the plain. The ridges are steeper in the south and become broad gentle swells approaching the shore.

A sequence of prominent ridges follows a major anticline along a line joining Springhill, Oxford Junction, and Malagash. This and another anticline extending from Joggins and Nappan almost to the River Philip bring Mississippian rocks to the surface. The well-known exposure of fossiliferous strata in the cliffs at Joggins occurs in the steeply inclined strata on the southern flank of this second anticline.

Parallelism of ridges, valleys, and streams is virtually absent in the extreme west of the plain, and in the Amherst-Pugwash-Tidnish triangle where the Upper Carboniferous rocks were not subjected to intense folding.

Altogether the Carboniferous strata of the County are 25,000 ft thick. In addition to the variety of sandstones, shales, and conglomerates already mentioned, they contain some beds of limestone, coal, gypsum, and anhydrite. Bodies of salt attain considerable thickness between Pugwash, where it is presently mined, and Malagash, where it was formerly mined. Salt bodies are also exploited at Nappan.

The cover of glacial till on the Cumberland Lowland is deeper than that on the Cobequid Mountains. It is lodgement till (ground moraine) derived mainly from the underlying bedrocks, and little appears to have been transported far from its source. Ablation till is uncommon. Much of the till is stony, but stoniness decreases toward the north. The dominant texture is sandy loam, but there are substantial areas of sandy clay loam. The matrix of even the coarse-textured material is frequently very compact with a high bulk density. The preponderant color is reddish brown, grading into the redder tills of Permo-Carboniferous origin along the Northumberland shore, and browner and grayer colors in the west of the plain. The till cover is thinnest on ridges and over much of the area west of the Parrsboro Gap and Joggins, where some may be ablation till.

The stream drainage pattern of the plain was inherited from preglacial times. The chief rivers are the Hebert and Maccan flowing into Chignecto Bay, and the Philip and Wallace flowing into Northumberland Strait. They are consequent or superimposed rivers in broad valleys with narrow floodplains, traversing geological trends at right angles. In places the valleys contract to steeply incised trenches, such as on the Wallace, indicating rejuvenation by a relative fall in sea level. A rising sea level at the close of the Ice Age drowned the coastline and enlarged estuaries.

In the eastern part of the plain a strongly trellised pattern of drainage has been produced by the subsequent tributaries, which drain marshy east-west valleys. Some of the valleys contain shallow lakes, such as Big Lake, Dewar Lake, and Wigmore Lake. The trellised pattern is weaker in the central and western parts of the plain, but nonetheless streams conform to structural trends with little interference by glacial events. In the Amherst-Pugwash-Tidnish triangle, where 15 to 25 ft of compact till overlies only slightly folded strata, the drainage over large areas is indeterminate. Although the soils are fairly coarse-textured, there are large areas of depressional to moderately sloping wet land.

The shoreline around the head of the Cumberland Basin consists of large tracts of salt marsh, many of which have been reclaimed by means of dykes. They were produced by the powerful Fundy tides, and the sediments consist of silt and silty clay loam. The salt marshes and dykeland of the Chignecto Isthmus grade into large freshwater bogs north of Amherst and together these made an effective natural boundary to the province.

The Minas Basin Littoral

The third natural division of the County is made up of the two separate coastal areas south of the Cobequid Mountains. They are downfaulted and are underlain by Carboniferous rocks of the Fundy geosycline, along with Triassic sandstones and isolated remnants of basalt trap. Topography varies from almost level outwash gravel plain to rolling hills, and some steep-sided ridges.

Both the Parrsboro section and the smaller Advocate section have a fairly thin cover of glacial till, much of which is derived from gray Carboniferous shale and is a characteristic drab olive gray color. Textures of this material range from gravelly sandy loam to clay loam. Reddish brown and brown till occur wherever there is a significant contribution from red Carboniferous and Triassic sandstones and from trap rock.

Overlying the glacial tills are some extensive water-deposited sands and gravels in which glaciofluvial and glaciomarine facies have been recognized (34). They originated as hill-margin outwash and kames, some of which were reworked by marine action during a period of higher sea level to produce raised beaches. Streams crossing the area are sharply incised. The level surface of the gravels is interrupted by kettle holes and Borns has reported many periglacial frost wedges in the gravels (1). Cliffs and deep indentations endow the shoreline of this area with considerable scenic beauty.

Vegetation

The natural vegetation of the County is a product of its climate; some local variations are produced by topographic exposure and depth, nutrient supply, and drainage status of the soils. The indigenous forests have been altered in composition by logging and forest fires, so that little undisturbed forest remains, and there is none in the lowlands.

Forest covers 850,570 acres, or over 80% of the County. Thirty-one percent of the forest is classified as mixed-wood stands, 46% softwoods, and 23% hardwoods (Table 11), which reflects the marginal ecological advantage for softwood species in some situations and hardwoods in others.

Red spruce and balsam fir are the most abundant species and together with black spruce they constitute 87% of the softwood trees by volume of timber. There are much smaller volumes of white spruce, hemlock, jack pine, white pine, tamarack, and red pine in this order.* The maples account for over half of the hardwoods. Red maple ranks third in volume of all forest trees, followed by substantial volumes of sugar maple, yellow and white birches, and poplars. Other common trees are beech, gray (wire) birch, and white ash (Table 4).

In Loucks' forest classification scheme (22), the Cobequid Mountains are in the Maritime Uplands Ecoregion of the Sugar Maple - Yellow Birch - Fir Zone; the Cumberland Plain apart from the Chignecto coastal strip is in the Maritime Lowlands Ecoregion of the Red Spruce - Hemlock - Pine Zone; and the Minas Basin - Chignecto Bay coastal strip comes within the Fundy Bay Ecoregion of the Spruce - Fir Coast Zone. The abrupt relief of the Cobequid Mountains helps to delineate these regions fairly well.

The Cobequid Mountains support a forest of sugar maple, yellow birch, and

*Botanical names are given in Table 26.

Table 4. Volumes of tree species

Species	Volume (1,000 ft^3)	% of total	Species	Volume (1,000 ft^3)	% of total
White spruce	36,251	4.0	Yellow birch	38,085	4.3
Spruce, red and black	397,344	43.6	White birch	25,094	2.8
Fir	175,752	19.2	Oak	62	
Hemlock	15,152	1.8	Aspen or poplar	30,853	3.4
White pine	9,426	1.0	Gray birch	9,255	1.0
Red pine	1,727	0.2	White ash	2,190	0.2
Larch	8,678	0.9	Black ash	328	
Jack pine	13,831	1.5	Cherry	257	
Scots pine	28		Elm	719	0.1
Sugar maple	42,918	4.7	Beech	13,854	1.5
Red maple	88,764	9.7	Miscellaneous	633	0.1
			Total forest land	911,211	100.0

Note: 1 cord of rough softwood = 85 ft^3 of solid wood.
Data from Nova Scotia Forest Inventory, Truro Subdivision, N.S. Department of Lands and Forests, 1968.

beech interlaced with mixed woods of red and white spruce, balsam fir, hemlock, red maple, sugar maple, and yellow birch and with more conifers on the steeper slopes and in the valleys. Poorly drained depressions support fir and black spruce. The northern part of the plateau has the purest hardwoods and to the south conifers are increasingly common. This forest association prevails above 500 ft except in the west where extensive red spruce stands of the moist and cooler Spruce – Fir Zone thrive up to the 700-ft contour.

An important limiting factor in the Cobequids is exposure to winds and neither red spruce nor yellow birch grow well unless shielded by more tolerant species. Although infertile, the stony soils of the Cobequids possess a slightly higher nutrient status than many soils in the County. This and the broadleaf litter are at least partly responsible for the luxuriant shrub growth in clearings and under the hardwoods. The competition from quick-growing mountain maple, beaked hazelnut, and hobblebush can greatly delay hardwood regeneration. Characteristic species of ground flora are wood-sorrel, wood-fern, and shining clubmoss. Blueberry is naturally uncommon but is widely cultivated on accessible gently sloping parts of the Cobequids.

The Cumberland Plain supports a distinctive association of red spruce, white spruce, black spruce, balsam fir, maples, hemlock, and white pine. Imperfect soil drainage encourages scattered tamarack and poplar. Black spruce is the main species, and tamarack is prominent on large areas of poorly drained soils and swamp margins. Jack pine and red pine occur on droughty sands and gravels.

Strong winds along the Northumberland shore affect the forest vegetation, particularly the red spruce. Nevertheless, this species remains abundant, growing best where sheltered. White spruce is more tolerant of wind than red spruce and because it also readily colonizes abandoned farm land, it is more plentiful along the coast. Regardless of species composition, second-growth stands in this area are slow

growing unless protected. Over much of the lowland area the moist and slowly permeable soils are significant factors; this forest association exists on all types of topography except some drier and more exposed upper slopes, which support sugar maple, yellow birch, and beech woodland.

There has been a long history of clearing and burning in the Cumberland Plain, which is reflected in the vegetation. Extensive areas of old barren exist between Harrison Settlement and Springhill, between Oxford and Greenville, and elsewhere. Competition from active shrub growth on such areas has often hindered regeneration of softwoods, leaving only scrubby red maple, wire birch, white birch, and trembling aspen. Red and white spruce take over favored locations. Jack pine has colonized dry areas of sand and gravel that have been burned and in some cases form pure stands.

Abandoned farmland in the Cumberland Plain reverts to speckled alder shrubs and white spruce. Alders abound on imperfectly and poorly drained fields that have been neglected, and they choke disused tracks. White spruce thrives on imperfectly to moderately well drained old fields, either as dense stands or in open competition with shrubs. Red spruce is a less frequent colonizer.

Prominent shrub and herb species on the Cumberland Plain include witherod, rhodora, sheep-laurel, sweet-fern, wood-fern, Labrador tea, and wild raspberry. Common smaller plants are wintergreen, goldthread, naked miterwort, bunchberry, bristly clubmoss, sphagum and hypnum mosses, Schreber's moss, and wood-sorrel.

The Fundy Bay Ecoregion, within which the Minas and Chignecto coastal strips fall, is characterized by late springs, cool summers, exposure to winds, and frequent fogs. Shallow soils over bedrock are common. Red spruce, balsam fir, and red maple dominate the forest association; trees are stunted where exposure is extreme and the soils shallowest, but they grow well on good protected sites. Some white spruce, white birch, yellow birch, and mountain ash are scattered among the dominants; sugar maple and beech come in at higher elevations at the boundary with the hardwood associations on the Cobequids. Distinctive features of the coastal area are colonization of abandoned farmland by red spruce rather than white spruce, and the absence of white pine and hemlock. The ground flora under the forest is frequently quite thin. In clearings typical species are foxberry and raspberry.

The vegetation of the peat bogs scattered through the County includes a wide variety of mosses and sedges, Labrador tea, pitcher plant, sheep-laurel, and rhodora. Stunted black spruce, tamarack, and white birch survive on some bogs, particularly around their margins.

On coastal salt marshes the natural vegetation consists of salt-tolerant species of grasses, sedges, and rushes, among which cord-grass, broadleaf, toad rush, sea-rocket, sand spurrey, and glasswort are prominent. The natural species were replaced by timothy, clovers, and other cultivated species on the substantial areas of marsh reclaimed by dyking. Much of the dykeland is in a neglected state today and the run-down pasture sward includes couch grass, browntop, and poverty-grass.

Relationships between vegetation and the soils over small areas are at best tenuous. They are strongest in respect to soil drainage, but even this relationship is ill-defined and frequently breaks down. Black spruce, tamarack, alders, Labrador tea, rhodora, pitcher plant, the sedges, and cotton grass favor, or tolerate better, the poorly drained soils. The range of tamarack and alder extends to imperfectly drained soils with which poplar and white birch are also associated. Pines hold a competitive advantage on excessively drained sands and gravels, but all three main

species, and especially white pine, occur on moister soils. The distribution of hydrophytic ground flora is often related as much to the density of the forest canopy as to soil moisture status, but continuous sphagnum moss cover always indicates poor or very poor soil drainage.

The pattern of vegetation distribution is further complicated by availability of seed plants, so that pine may be absent from suitable sandy soils through the local absence of seed trees. Balsam fir appears to favor fairly moist soil, but its ability to regenerate in the shade of other species ensures its spread into well-drained areas.

Relationships between vegetation and other soil characteristics such as texture and structure are rarely apparent, except insomuch as these qualities affect the drainage. Natural fertility differences among Cumberland County soils are so slight as to be barely perceptible in either natural vegetation or cultivated plants. The somewhat higher base status derived from ferromagnesian minerals may have something to do with the prevalence of hardwood trees in the Cobequid Mountains and the rich undergrowth there, but this effect is difficult to separate from the adverse effect of exposure on the conifers. The shales of the Minas Basin shore appear to support a more luxurious forest growth, and this might be due to greater release of bases in the soils.

History of Development

Cumberland County is one of the leading agricultural and lumbering counties in the province. It contains relatively large areas of land potentially suitable for farming, important inshore fisheries, accessible and formerly excellent forests, and mineral resources. However, its early economic development was rather slow.

The area was thinly populated by Micmac Indians when the earliest white settlers, mainly French pioneer farmers, arrived. Their first organized settlement was founded at Beaubassin on the Isthmus of Chignecto in 1696, almost a century after the first stockade was built in the province at Port Royal. Nova Scotia came under British rule in 1713, but Beaubassin continued as a mainly French settlement. Its progress was such that it over-shadowed Port Royal by 1755, when the Acadians were expelled after refusing to take the oath of loyalty to the British Crown.

The settlers had subsisted in simple fashion off farmland reclaimed by dyking the vast salt marshes, a technique they had perfected in the marshes of the west coast of France and that saved them much laborious clearing of trees. Any surplus produce was sold to the military garrisons.

For several years after the expulsion the land remained virtually empty apart from the soldiers at Fort Lawrence and Fort Cumberland in the Isthmus. In 1759 the township of Cumberland was formed and settlement of the Isthmus area was renewed by colonists from the New England states. Census figures show 65 families at the two forts in 1763 when the total white population of the province was 13,000. Settlements were established at Parrsboro in 1775 and at Pugwash, Wallace, and Fox Harbour in 1812. The early importance of Parrsboro came from its position on the only road from Fort Cumberland to Halifax and from the ferry service linking it to Windsor.

The economic development of the area was not rapid; land speculation and the uncertainty of tenure had an adverse effect. Life on the farms was hard and unremunerative, and much farming was a part-time activity in combination with fishing and forestry. The situation improved somewhat in the latter part of the eighteenth century. Organized settlement received an impetus with the arrival of

shiploads of Yorkshire families (1772–1774) and the much larger numbers of United Empire Loyalists (1783).

As roads improved, there was less dependence on coastwise transport and settlement slowly spread to the broad drier ridges in the interior. During the nineteenth century, a mixed-farming system gradually increased to its maximum extent in the Cumberland Plain and the Parrsboro Shore, but to many it remained a part-time occupation. Conditions suited livestock, which was the mainstay of the farming system. Small but developing population centers, both within and outside the County, became significant markets for agricultural produce. Agricultural trends in the present century are dealt with in a later section.

The forests supplied a persistent demand from the shipbuilding industry, both in Britain and in the County at Nappan and Parrsboro. As the shipbuilding demand declined, a wider lumbering trade for the construction industry and a local demand for pit props maintained pressure on the forests. This has been increased by the pulpwood industry, and rapacious cutting has left a legacy of low-quality forest, much of it choked with poor second growth.

By the year 1871 the population of the County had risen to 23,518. From the middle of the century Amherst and Oxford began to emerge as minor industrial centers. Amherst, the county seat, enjoyed the greatest economic momentum and its industries eventually included lumber mills, foundries, engineering works, car shops, and a footwear factory. Oxford at its maximum development possessed a small foundry, a furniture factory, and a woollen mill. Coal mining began at Joggins in 1866, but Springhill soon became the chief mining town. Small mines were in operation at River Hebert and Maccan.

Population, Industry, and Communications

The population of the County attained a maximum in the 1920's and at the census of 1921 numbered 41,191. After a period of fluctuation, it entered a phase of steady decline in the early fifties, falling to 37,767 in 1961 and 35,933 in 1966. The principal centers are Amherst (10,551), Springhill (5,380), Parrsboro (1,835), and Oxford (1,426). The populations of these towns are remaining static or declining slightly and rural depopulation has contributed most to the county-wide decline.

Amherst, the county seat, has remained the dominant industrial center. Located in the town are a foundry, a timber mill, and plants engaged in general engineering, steel fabrication, printing, the manufacture of polyethylene film products, textiles, and dairy products. At nearby Nappan, locally mined salt is processed.

The Springhill coalfield yields a fraction of its former coal production from its single remaining mine; the town's other industries include a car battery factory, a frozen fruit plant, and a carpet factory. The town is the site of a large modern penitentiary. Parrsboro has a large sawmill, a frozen fruit plant, and a boat building industry. At Oxford there is a small foundry, a sawmill, a large greenhouse operation, and a new freezing plant; a small modern textile plant has replaced the old woollen mill.

Apart from a large salt mine and a processing plant at Pugwash, industrial activity elsewhere in the County consists of small enterprises. Coal is mined on a small scale at River Hebert and Joggins; sandstone is quarried on a much reduced scale at the large Wallace quarry to meet an intermittent demand of the building trade; sand and gravel operations are dotted around the County, with some concentration in the River Philip valley.

Fig. 4. Population of Cumberland County, 1871–1966.

The road and rail networks of the County are shown in Fig. 5. The historical alignment of the main interprovincial highway by way of Amherst and the Parrsboro Gap was shifted in recent years to a route via Oxford and the Wentworth Valley. This is the route followed by the newly completed Trans-Canada Highway. The old road network adequately serves the population centers and the Sunrise Trail provides paved access for tourist traffic to the whole Northumberland shore. A relatively dense network of secondary unpaved roads provides most rural communities with excellent communications, especially in the eastern part of the Cumberland Plain, where they conform with the east–west pattern of ridges and valleys. The transverse roads present some difficulties in the spring at points where they cross the wet valleys and depressions. West of Oxford, the roads form a less dense network and in the unpopulated area west of the Maccan River they are as rare as in the Cobequid Mountains.

The main Canadian National Railways line linking the province with the rest of the country passes through the center of the County. It traverses the Cobequids by way of the Wentworth Valley, probably the most scenic stretch between Halifax and Montreal. A line branching off at Oxford Junction provides a limited freight service to Pugwash and east along the coast to New Glasgow.

The best harbor is at Pugwash where the modern wharf can accommodate two ocean-going vessels; it is an important outlet for timber and salt. Lesser harbors are situated at Wallace, Parrsboro, and Advocate, and scores of inshore fishing wharves are scattered around the coastline.

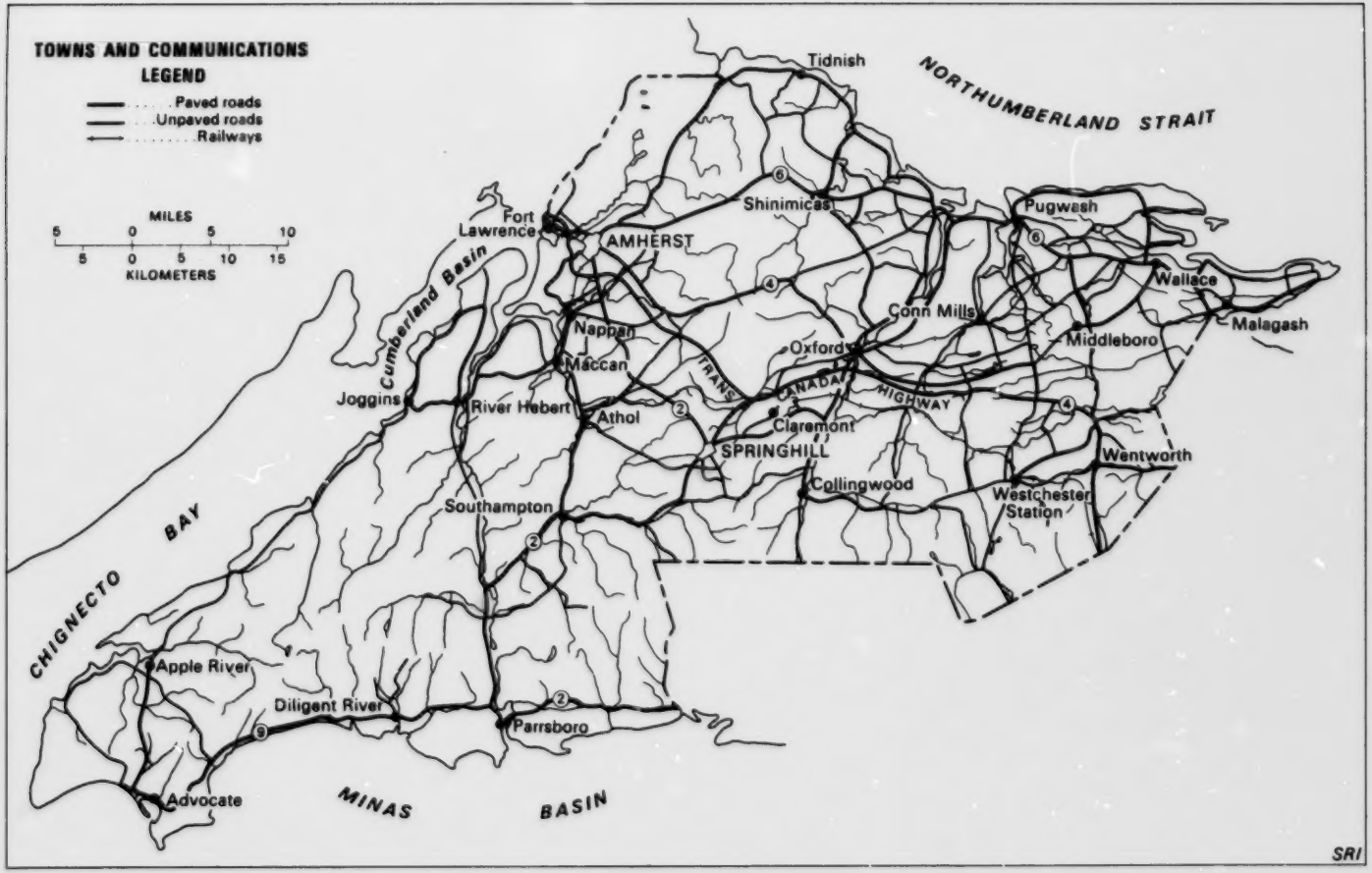

Fig. 5. Towns and communications.

HOW THE SOILS WERE MAPPED

Mapping Procedure

Mapping was conducted on a semidetailed scale in most agricultural areas and on a reconnaissance scale on forested lands. This approach was adopted to provide a soil map of the County within a reasonable time. The map accompanying this report is on a scale of 1 mile to 1 inch, which scarcely permits the detail that some users demand for field-by-field farm planning. The presentation of greater detail on a larger scale, and also more thorough coverage of forested land, would have prolonged the survey by several years. The map shows the general distribution of the different soils and the map legend and the report indicate what kinds of soil might be encountered upon close inspection of areas too small to be shown on the map. Locally observed variations, such as those created by intricate drainage patterns, can be identified by reference to the soil report and its comprehensive soil descriptions.

The differences in soil parent material, texture, color, drainage, structure, and consistence were used to separate the soils of the County into groups called *soil series*. The soil series is the basic unit of mapping. The soils in each series have developed from the same kind of parent material and possess the same profile and drainage characteristics within narrowly defined limits. An exact definition is given in the glossary.

A mapping unit designated as a soil series on the map frequently contains areas of other soils that are too small to be delineated separately. These "foreign" inclusions amount to about 15% or less of the area of each mapping unit.

The boundaries between series were determined by examining the soils at frequent intervals; the frequency was partly governed by the variability of soils in the area. Profiles were examined in pits dug for the purpose and auger holes, within walking distance of roads, logging trails, and railway tracks. Roadside cuttings were closely examined. The soils and their boundaries were plotted on air photographs at a scale of 4 inches to 1 mile. Classes of stoniness and slope were recorded for each series in order to delineate soil phases within the series.

Vegetation, crops, agricultural practices, and the suitability of the soils for various uses were noted. Samples of the soils were collected for physical and chemical analysis; the results are presented in the separate appendix at the back of the report.

The Soil Profile

The soil-forming processes have produced changes in the soil material, which can be observed in a vertical section or soil profile. The soil profile exhibits layers that differ from each other in color, thickness, texture, structure, and consistence. These are the result of additions, losses, translocations, and transformations brought about by the interaction of the soil-forming factors as they reflect the operation of a particular kind of process.

The upper part of the profile from which substances have been removed or leached is called the A horizon. The middle part, where some of the substances have accumulated or where the existing material has been sufficiently altered, is called the B horizon. The underlying material, similar to that in which the A and B horizons developed but relatively unaffected by soil-forming processes, is called the C horizon. Each of these horizons may have subhorizons with different characteristics.

LEGEND

MAP UNIT	TEXTURE	DRAINAGE CLASS	PARENT MATERIAL AND LAND FORM	DOMINANT SUBGROUP	INCLUDED SOIL SERIES
1	Moderately fine	*	Tidal sediments on level marine plain	Gleyed Regosol	Acadia and associates
2	Moderately coarse	Poorly drained	Shallow, dense stony till on gentle slopes	Orthic Gleysol	Economy
3	Medium over coarse-skeletal	Well drained	Shallow shaly till on gently to strongly rolling hills	Orthic Humo-Ferric Podzol	Kirkhill
4	Medium to moderately fine	Poorly drained	Medium- to moderately fine-textured stream alluvium	Rego Gleysol	Chaswood
5	Moderately coarse over coarse-skeletal	Well drained	Shallow stony till on rolling to steep hills	Orthic Ferro-Humic Podzol	Cobequid, Wyvern Rossway
6	Moderately coarse to medium	Imperfectly drained	Dense till on undulating to rolling plain	Gleyed Degraded Dystric Brunisol	Debert, Springhill
7	Moderately coarse over coarse-skeletal	Well drained	Stony, commonly shallow till on rolling plain and upland	Orthic Humo-Ferric Podzol	Rodney, Shulie Westbrook
8	Coarse and coarse-skeletal	Rapidly drained	Undulating to rolling glaciofluvial sands and gravels	Orthic Humo-Ferric Podzol	Hebert
9	Moderately fine	Poorly drained	Dense, weakly calcareous till on undulating plain	Low Humic Eluviated Gleysol	Joggins, Kingsville
10	Moderately coarse to medium	Poorly drained	Dense, weakly calcareous till on undulating plain	Orthic Gleysol	Masstown
11	Moderately fine	Imperfectly drained	Dense, weakly calcareous till on gently rolling plain	Gleyed Gray Luvisol	Queens, Diligence
12	Moderately coarse to medium	Well drained	Dense sandstone till on gently rolling plain	Orthic Humo-Ferric Podzol	Hansford, Pugwash Tormentine
13	—	Poorly drained	Sphagnum bogs	Fibrisols	Organic soils

The map units are soil families, except for units 1, 5, 7, 9, and 13 that contain two or more families.

* Imperfectly to poorly drained

Fig. 6. Generalized soil map.

Fig. 7. Terminal moraine and kames, Parrsboro Gap. Hebert soils with Cobequid soils on the hills.

These are denoted by an appropriate subscript after the master horizon designation; for example, Ae denotes a strongly eluviated (leached) part of the A horizon. Characteristic features of the horizons are the basis for classifying soils. The criteria used are the number and sequence of horizons and their thickness, color, texture, structure, consistence, and mineral and chemical composition.

Each soil does not have sharp boundaries but merges gradually into others with different properties. Soil is a three-dimensional continuum and features of each horizon vary both laterally and vertically. It is, therefore, necessary to choose the range of variations of features considered characteristic of each soil.

Soil Classification

Variations in the characteristics of the soil profile are the basis for classifying soils. The different soil series in which the soils of Cumberland County have been placed are subdivisions within country-wide groups of soils called Great Groups and Subgroups. At these high levels in the Canadian soil classification scheme soils are grouped according to the kinds and intensity of the processes that produced them. These processes are reflected in distinctive types of profile that cover large areas more or less regardless of the type of materials.

Soil classification at the great group and subgroup levels are of limited interest to many readers, but a discussion of these aspects can be found in the more technical material in Part II of this report.

DESCRIPTION OF THE SOILS

In this section the various soils, chiefly soil series, are described in alphabetical order to provide information on their extent and location, and characteristics of the land surface and the soil profile. Brief mention is made of the present use and the main management problems. In the section "Land Use" there is more information on the utilization, productivity, and capability of the soils.

The names given to each soil series conform to a nationwide scheme and are generally derived from the locations where the soil was first recognized and mapped. The total acreage in each topographic and stoniness phase of each soil series is given in Table 25.

A generalized profile description is given for each soil series, and the range in characteristics and local aberrations are noted. Detailed descriptions of specific profiles representing each series are given in Part II and the analytical data on samples taken are bound together in the separate appendix (Appendix 2).

The use of some technical terms is unavoidable in the interests of brevity. These terms are explained in the glossary at the end of the report. The soil textures, e.g., sandy loam and clay loam, were estimated in the field and confirmed in many cases by laboratory analysis. A rough approximation is easy to obtain in the field, and as an aid to more accurate description of soils, a guide to the field determination of texture is given in Appendix 1.

Acadia Soil Complex (14,223 acres)

Most of the Acadia soils fringe the Chignecto Bay arm of the Bay of Fundy where they have been reclaimed from salt marsh. Three main blocks, the Amherst Marsh – Missaquash River area, the Nappan area, and the Minudie Peninsula, account for 85% of the acreage. The sediments that form the parent materials of these young dykeland soils were laid down by the powerful action of the Fundy tides and are silty clay loam in texture. The level topography is broken only by shallow, very poorly drained depressions and many of these are situated at the inner edge adjacent to the till upland. Elsewhere drainage has been classified as poor to imperfect, depending partly upon the proximity to tidal channels and aboiteaux (sluices) and partly upon the depth to a subsurface layer of dense gray silty clay loam.

There has been almost no horizon development in the soils, but depositional layers of different colors and textures may be encountered. A reddish brown or dark brown upper layer generally overlies a dark gray to bluish gray subsurface layer at depths from 12 to 36 inches or more. Although the marked color difference may indicate real differences in the original material, the gray color is probably a reflection of a higher organic content and more intense reduction during and after deposition of the sediments. The reddish brown material appears to be more oxidized. Mineralogically the two layers are very similar, except that the hydrated iron oxide, goethite, is present in the grayish material but not in the reddish brown material (5). The reddish brown layer is of silt loam to silty clay loam texture and has a fairly well developed fine to medium granular or subangular blocky structure. It is mottled in all but the better drained locations, and the mottles become more prominent and more numerous as drainage deteriorates. Organic matter in the plow layer gives it a brown, dark brown, or dark reddish brown color. The surface soil is leached and some areas are quite strongly acid, but the pH rises rapidly with depth.

The boundary between the upper reddish brown and the underlying gray

Fig. 8. Acadia soils on the marine alluvium of the dykeland of Minudie Community Pasture.

Fig. 9. Acadia soils on River Hebert dykeland; Shulie soils on the till upland.

material is frequently abrupt. The gray material is of similar texture but is generally dense, massive, and virtually impermeable and contains more organic matter. Occasionally it may be mildly alkaline due to the presence of salts, but on the whole it is extremely acid. Some layers with a high organic matter content have pH values so low that sulfates are reduced to sulfides, as evidenced by the foul smell of hydrogen sulfide. The gray material is usually prominently mottled, especially in the upper part.

The range in characteristics of Acadia soils is too wide for them to be designated as a soil series. In addition to the variability in drainage status, pH, and depth to the dense gray layer already noted, soil textures occur that are both coarser and finer than those described. Small areas of Acadia soils at Advocate and along the Northumberland Strait are more sandy than normal. Sandy lenses occur sporadically in many Acadia profiles. At the other extreme, textures as fine as silty clay have been found in the subsurface grayish material. In some areas the reddish brown surface layer is absent and dark grayish material is found at the surface.

Many of the very poorly drained and some of the poorly drained Acadia soils contain layers of peat on or below the surface, or they have a very high percentage of intermixed organic material. The peat is mainly the semidecomposed remnants of salt marsh plants, and some of it was later buried under further accumulations of sediment. Drainage of such areas involves the special problem of shrinkage and subsidence.

On the soil map, Acadia soils have been separated into three groups: (i) imperfectly and poorly drained soils composed mainly of reddish brown material in the top 36 inches; (ii) poorly drained soils composed of the grayish material to within 12 inches of the surface; (iii) very poorly drained soils composed of either reddish brown or grayish material, which may contain peaty layers at or below the surface. Where 16 inches or more of peat has accumulated on the surface, the soil is mapped as peat.

Use

Selecting potentially the most fertile soils in the area, Acadian French settlers devoted their special skills to the dyking and reclamation of open salt marsh. Thus, the flat dykelands of the Maritime Provinces came to occupy a distinctive position in North American history as the site of the earliest European agriculture. Further reclamation greatly extended the acreage of Acadia soils, but with a few exceptions little of their potential is at present being realized in Cumberland County.

Leaching and drainage have removed any salinity problem except where the dykes have fallen into disrepair, allowing periodic flooding with sea water. In very few areas capillary rise in extended dry periods can bring up salt from shallow saline layers. Newly reclaimed and freshly flooded soils contain 2% or more of soluble salt. Injury to sensitive plants such as beans, peas, red clover, oats, and wheat begins at 0.1 to 0.4% NaCl. Ladino and sweet clover, rye, and barley tolerate 0.4 to 0.6%; tomatoes, alfalfa, timothy, kale, and rape tolerate 0.6 to 0.8%; the most tolerant crops, bromegrass, beets, and mangolds tolerate 0.8 to 1.0% salt (19).

At present the chief limitation on the use of Acadia soils is excessive fresh water. This arises from the inadequacy of field drainage systems, the neglect of old ditches, the natural silting of some of the tidal channels that provide the essential outfall, the remoteness of some natural depressions from adequate outfall, and the inherent impermeability of soils in which the dense grayish material comes near to the surface.

Twenty percent of the Minudie-Nappan area is adequately drained for crop production and a further 15% only requires more lateral ditches. In the Amherst Marsh - Missaquash River area only 14% is adequately drained and extensive ditching would be required to bring into full use more than another 5 to 10%. Roughly one-half of the acreage along the Maccan and Herbert rivers is drained sufficiently for crop production.

Liming is required on most of the Acadia soils because the surface layers have been rendered acid by leaching, or by the acidic grayish material when present at the surface. The soils are unique in Nova Scotia in containing sufficient levels of major plant nutrients for most needs, but the release of phosphorus in the naturally more acid soils depends upon adequate liming (19).

The present productivity of Acadia soils in Cumberland County compares poorly with that of the same soils in Kings County, and the possibilities demonstrated at the Experimental Farm at Nappan. Hay is the chief crop, but most of it is of poor quality. There are only limited acreages of good fodder crops, even though alfalfa has been grown successfully on these soils. Acreages of cereals and roots are very low. The Minudie area is under fairly intensive use as a community pasture.

To make the best use of the Acadia soils it is necessary to determine and follow the most effective and economic methods to secure adequate field drainage. The fragmentation of land holdings frustrates drainage and little progress can be made without consolidation of the land. Amherst Marsh would benefit if the huge volume of overland flow and seepage could be impounded in the upper La Planche catchment. The upper area might then become a wildfowl sanctuary, similar to the one on the nearby Missaquash River.

Bridgeville Series (858 acres)

The Bridgeville soils are found in small pockets throughout the County on imperfectly drained parts of floodplains. The land is fairly level and, although free from large stones, may have considerable amounts of coarse gravel on and below the surface. Textures of the fine earth range from sand to loam. Despite the fact that water passes quite rapidly through this material, a high water table maintains saturated conditions within the plant rooting zone for extended periods at the beginning and the end of the growing season.

Bridgeville soils resemble Cumberland soils except for the effects of the higher water table. This restricts the rooting zone by creating a poorly aerated environment, which is expressed by mottling to within 12 inches of the surface. The mottles may only be faint. The surface layer contains more organic matter than in the Cumberland soils and tends to have a darker color and a more strongly developed fine blocky structure.

The amount of gravel in Bridgeville soils is variable; there may be gravel lenses, as in the profile described in Part II, and even a dominantly gravelly subsoil, but this feature is less common than in the Cumberland soils. The Bridgeville soils may be regarded as the imperfectly drained equivalents of the well-drained Cumberland soils. At the other extreme they merge into the poorly drained Chaswood soils, which are marked by more intensive mottling and generally finer textures.

Use

Bridgeville soils have some of the agricultural advantages of the Cumberland soils, but plants growing on them rarely lack moisture and usually it is excessive. The soils are generally more prone to flooding.

Bridgeville soils are now used as hay and pasture land, but with artificial drainage, which can be very effective on these soils, a range of crops can be grown with yields equivalent to those from Cumberland soils.

Chaswood Series (6,875 acres)

One-quarter of the Chaswood soils occupy the broad flat valley floor north and south of Newville Lake in the Parrsboro Gap. The remainder are scattered throughout the valleys that crisscross the Cumberland Plain in small areas of impeded drainage and swamps. The soil parent material is medium- to moderately fine-textured alluvium deposited from the floodwaters of present-day streams. In a few areas the deposits may be of lacustrine origin. They have a level to very gently sloping surface over which streams meander slowly, so that both surface and internal drainage are poor or very poor. Many of the soils are under open areas of sedges, rushes, and water-tolerant grasses, whereas others support a retarded growth of black spruce and tamarack. Very few areas have been drained for agriculture.

The surface of Chaswood soils is highly organic because the wet conditions delay the oxidation of organic matter, allowing it to accumulate in several inches of humic peaty mor. Its finer components have moved downwards in some cases to stain some of the mineral soil. The underlying mineral soil exhibits a variety of colors and textures, but the most common form is a dark gray or grayish brown silt loam or silty clay loam. Yellowish mottles are prominent in the top 18 inches of the soil but give way to a drab gleyed subsoil, into which air rarely penetrates because of continuous saturation with stagnant water.

These soils do not exhibit pedogenic horizons, because soil-forming processes have been overtaken by a fresh deposition of sediments. They are amorphous and have little structural aggregation even at the surface. The density of the subsoil is often such that water can move only very slowly in both vertical and lateral directions. Sedimentary layers of different texture and color, including saturated beds of gravel, are a common feature in the profile.

A few small areas of saturated sandy soils have been included in the Chaswood Series; they represent an intergrade to the related Bridgeville Series. Many of the wetter Chaswood soils in basin sites grade into peat soils where the surface organic matter has accumulated to a thickness of 16 inches.

Use

As a result of frequent flooding, slow permeability, negligible runoff gradients, and local seepage from upland areas Chaswood soils remain saturated near the surface for long periods in the year. Attempts at artificial drainage are not helped by the low hydraulic conductivity in the finer-textured soils. Hence, very little of the area has been used for agriculture, except as rough pasture, and little potential can be envisaged.

Cobequid Series (84,223 acres)

The Cobequid soils cover over 8% of the County, and are found on rolling and hilly land in the Cobequid Mountains. This is a plateau on which the rolling relief is accentuated by many deeply incised valleys. The soils are well drained, very stony, and extremely acid. They have developed from a thin coarse-textured glacial till mantle, composed of essentially the same mixture of igneous and metamorphic rocks as the underlying bedrock, in which felsite, diorite, granite, and syenite are prominent. Over large areas the bedrock is within 2 ft of the surface and outcrops are quite common. Hardwood species are prominent in the forest cover and were formerly more widespread. Ninety-five percent of the Cobequid soils occur between the 500-ft contour and the 1,000-ft summit level, where, compared with the lowland, cooler and more moist climatic conditions have been responsible for a greater accumulation of colloidal organic matter in the soils.

There is a great diversity of humus forms, but under the hardwoods that cover much of the Cobequid soils, it is generally mechanically mixed by the microfauna. Highly decomposed organic material is mixed with both the overlying semidecomposed plant remains and with some mineral material from below. There is a grayish loamy leached horizon (Ae), rarely more than 2 inches thick. This rests upon a 4- to 6-inch layer of characteristic bright yellowish red sandy loam, which is friable, granular, somewhat fluffy, and highly porous. It contains at least 10% organic matter, which was deposited in association with Fe and Al compounds. The underlying horizon has less organic matter and a less well developed structure, but it is easily penetrated by roots and provides a good rooting zone for trees.

The distinctive olive brown color of the parent material is encountered at 18 inches. Gravel and stones of all sizes are common throughout the soil profile but reach a maximum in the lower B and C horizons, where the soil is of gravelly sandy loam texture. Fragmented bedrock is often found at a depth of 2 ft.

The surface soil may range in texture from sandy loam to silt loam. Textures are notably finer than in the underlying soil as a result of intense weathering and this is especially true on the gentler topography. Locally a 2- to 3-inch layer of granular humus (Ah) has been produced by the intimate intermixing of surface organic matter and loamy mineral soil. Variations in the color of the parent material were noted; the characteristic olive brown color gave way to reddish brown colors in some areas, which seemed to indicate a gradation into Wyvern and Westbrook soils.

Imperfectly and poorly drained counterparts of the Cobequid soils, with mottling and drab colors in the profile, can be found in depressions and seepage spots in the hills. They have not been mapped separately because individual areas and the total area are small.

Use

Although small areas were cleared of stone and cultivated in the past, the Cobequid soils are far too stony or shallow to be used for agriculture. A small acreage is under lowbush blueberry cultivation. They are excellent forest soils, offering a porous but solid rooting medium. The hardwoods have been extensively cut in the past, and the numbers of softwood species have increased in accessible areas. Climatic exposure is an adverse factor on much of the area, and access is difficult on the rougher terrain.

Cumberland Series (8,274 acres)

The Cumberland soils are young, immature sandy loams and loams on well-drained alluvial deposits and are distributed throughout the County in strips along stream margins or floodplains. The only substantial tracts are in the Southampton–Westbrook area, the River Philip valley, and the Wentworth area. The land is gently sloping except where dissected by old stream channels. The soil is free from large stones, but in some areas it may be very gravelly. Most of the soils are subject to occasional inundation by floodwaters, but some areas escape much seasonal flooding. Periodic replenishment with fresh material has overcome the worst effects of leaching, so that the soils are relatively more fertile and less acid than upland soils. They are porous and permeable and natural drainage ranges from moderately good to excessive. Very few of the Cumberland soils are forested, but scrub covers areas where agriculture is excluded by frequent flooding or excessive coarse gravel.

Cumberland soils do not have horizons produced by soil-forming processes, but distinct depositional layers of different color and texture may be present. The better soils, with good water-holding capacity and a loamy texture, are generally of uniform brown color to a depth of 2 ft or more under a plow layer of similar or darker color. The organic matter content is usually a fairly uniform 3 to 5% to a depth of 2 to 3 ft and somewhat higher in the plow layer. Structural aggregation and rooting extends to a depth of 2 to 3 ft and the friable surface soil can be worked over a wide range of moisture content.

Bridgeville soils are related, but they are imperfectly drained over a high water

Fig. 10. Carrots, raspberries, and corn growing on alluvial Cumberland soils, River Philip.

table. They can be recognized by the mottling within 18 inches of the surface produced by poor aeration. Cumberland soils may be mottled but only at depth.

Use

The demonstrated value of many Cumberland soils for a wide variety of crops is marred in some areas by susceptibility to flooding and the restricted air drainage that allows frost pockets to form. Where underlying gravel beds come within 2 or 3 ft of the surface and on elevated spots, droughtiness in middle and late summer is a problem. Maintenance of a high organic matter content helps to counter mild droughtiness, but for many crops irrigation is essential. Cumberland soils in the River Philip valley are extensively irrigated for the production of strawberries, the kind of crop for which these soils are well suited.

Subsurface gravel beds have attracted gravel operations, and this conflict of interest is unfortunate where so many other sources of gravel are available, for instance, under the agriculturally less valuable Hebert soils.

Debert Series (143,433 acres)

Debert soils occur in the northern and central Cumberland Plain and occupy nearly 14% of the County. They form the imperfectly drained associate of the Tormentine and Pugwash series and the poorly drained Masstown Series. They have developed from essentially the same parent materials, namely reddish brown to dark red glacial till in which red Carboniferous and Permo-Carboniferous sandstones are the chief constituents. The imperfect drainage is due partly to the compact nature of the till and partly to the moderately or strongly developed fragipan and fairly slow surface drainage. Debert soils are commonly found on the level summits and gently sloping flanks of low broad ridges and in some of the intervening depressions. Surface stoniness is slight to moderate, but on nearly 10% of these soils it is sufficient to preclude agricultural use.

Debert soils are dominantly sandy loams, but there is enough clay or silt in the B and C horizons of some of the soils to give a loamy texture. Beneath the forest humus, undisturbed profiles display a bleached A horizon, which is faintly mottled in its lower part. This grades into a gleyed, distinctly mottled horizon with a platy structure, which, although no more than a few inches thick, is a conspicuous characteristic of these soils. There may be a weak podzolic B horizon up to 4 inches thick.

Normally, there is little colloidal organic matter in the B horizon, but in a few localities it has accumulated in a dark gray 2-inch layer at the top of the horizon. At Leicester and Middleboro, this constitutes a weak ortstein layer.

Beneath the B horizon lies the fragipan, known to farmers as a hardpan, which extends from a depth of about 12 inches to 24 inches or more. Differing little in its color and extreme compactness from the underlying C horizon, it is differentiated by its coarse platy structure and network of pale gray vertical fracture planes. The platiness is rarely strongly developed, and although brittle when dry the structural units lose most of this brittleness when moist. The fine interplate voids permit fairly rapid lateral transmission of water, but vertical percolation is very slow. The fragipan is an effective barrier to both water and root penetration. Although the vertical gray fracture planes can transmit water to a depth of 3 or 4 ft, they are essentially closed channels in which water backs up. The fracture planes are 1/2 to 1 inch wide, spaced 18 to 36 inches apart, and filled with sandy material. Viewed

Fig. 11. Farmland on Debert and Tormentine soils on the undulating till plain in northern Cumberland County.

from above, after removal of overlying soil, they form a continuous polygonal network. In some profiles the fracture planes were observed to commence in the A horizon as humus-stained fissures. Black specks and concretions commonly found in the fragipan are MnO_2.

The C horizon is reddish brown to dark red in color and extremely compact. It is calcareous at depth, and the pH commonly reaches 7 at a depth of 4 ft. The effect of this horizon and the overlying fragipan upon soil drainage has been demonstrated by permeability measurements on soil cores in the laboratory. The Ae horizon transmitted water at a rate of 0.25 to 8 inches/hr. But the rate fell to 0.01 inch/hr in the fragipan (17 to 20 inches). Figures for the C horizon were 0.33 and 0.42 inch/hr. In a few areas, there is a 3-inch layer of dark grayish brown mull beneath the raw forest humus, indicating higher biological activity. In some cases this is due to earthworms spreading from nearby farmland. Cultivation of a Debert soil produces a brown to dark brown plow layer.

In some of the soils the fragipan is absent or only weakly developed, but the subsoil remains dense and slowly permeable. In a few widely separated areas, notably at Mount Pleasant, South Victoria, Pugwash, and Pugwash Junction, Debert soils are underlain at 4 to 10 ft by a compact reddish brown to dusky red sandy clay loam till akin to the parent material of the Queens soils. At a few exposures the material displayed a remarkable fine angular blocky structure with a very firm consistency and resembled a lacustrine deposit.

South of Salem and around Maccan, there is a diffuse transition from the

Debert to the Springhill Series in which gray sandstones impart a yellower hue to the whole soil profile. There is a second transition, to the Queens Series, involving no color change but a marked increase in clay content. The separating line is where the clay content of the parent material reaches 18 to 20% and it is an ill-defined boundary over large areas, especially east of Oxford and around Middleboro. The clay content of the Debert soils ranges from about 5 to 18%. At the higher clay contents the fragipan characteristics are less strongly developed, but the subsoil is equally dense.

Use

Forests on the Debert soils have as their main species red spruce, balsam fir, maples, black spruce, and birch, with some poplar and tamarack. White spruce and poplar are common on abandoned farmland. Extensive lumbering has been responsible for large areas of poor second growth in the forests.

Debert soils are the most extensive in the County and with adequate drainage they have a potential for a wide variety of crops. Their main use at present is in the production of oats, barley, and hay. Large areas are in permanent pasture. Some of the pastures are in good condition, but most have a low carrying capacity caused by the inadequate use of lime and fertilizers; remote fields are succumbing to colonization by spruce and alders. Considerable areas of Debert soils between Amherst and Pugwash have come under improved management in recent years and yield good crops of barley, wheat, and corn.

Although the imperfect drainage delays the warming of these soils in spring and interferes with access to the land, it is not considered an insurmountable problem. Subsurface drainage is needed, preferably in combination with practices to break up the fragipan. On the whole, the area offers considerable untapped potential for agriculture, but capital costs are high. Good levels of organic matter are required to improve the inherently poor soil structure, and liberal liming and fertilization are also essential.

Diligence Series (12,967 acres)

The Diligence soils occupy only 1.2% of the County and are located on undulating to moderately rolling land east and west of Parrsboro and on smaller areas near Springhill and River Hebert. Their parent material is a fine-textured glacial till in which grayish and reddish Carboniferous shales predominate with some admixture of fine-grained sandstones. This till is dense and generally shallow over slowly permeable bedrock, so that the soils are imperfectly drained in addition to being extremely acid. They are, therefore, of little agricultural importance and apart from a few run-down farms bordering the roads the soils are covered with second-growth forest.

On the surface of undisturbed Diligence soils there is a mor humus layer about 4 inches thick, which is quite variable in constitution depending upon the relative proportions of coniferous needles, hardwood leaves, and mosses. Both sphagnum and hypnum mosses are particularly abundant on these soils. The H layer may be up to 2 inches thick or absent entirely. Beneath lies a thin grayish brown or brown horizon (Ae or Aeg) of loam, silt loam, or clay loam, rarely more than 2 inches thick. Mottling may or may not be present. Where sufficient colloidal organic matter has penetrated the soil it possesses a well-developed granular structure.

Underneath there is a brown horizon several inches thick that is of rather finer

texture and is dominated by yellowish brown or strong brown mottling. In most cases it is best regarded as a gleyed transitional horizon (ABg). The material in the rest of the profile can be reddish brown, reddish gray, or grayish brown, depending upon the color of the shale from which it was derived. Its texture ranges from silt loam to silty clay, and it is always dense and virtually impenetrable for water and plant roots. Clay particles have migrated into it from above and many pores and structure planes contain thin clay films. The underlying C horizon is marked by an absence of structural development and clay films, and any difference in color is usually of geological origin.

The range in color and texture of Diligence subsoil has already been noted. The uppermost part of the B horizon sometimes contains enough "free iron" to be designated a podzolic B horizon. There are areas mapped as Diligence soils in which gleying and drainage are such that a rather arbitrary line separates them from the poorly drained soils mapped in the Joggins Series. A few Diligence profiles exhibit weakly developed vertical fracture planes of paler color than the matrix.

The coarser-textured Diligence soils that have better drainage and a high content of shaly gravel grade into the well-drained podzol soils of the Kirkhill Series.

Use

The Diligence soils are of little use for agriculture. In addition to the adverse factors already mentioned, i.e., impermeability, imperfect drainage, and acidity, 60% of these soils are too stony for farming.

The forests on Diligence soils have been exploited in the past and much of the present growth is of poor quality. Red spruce and balsam fir are the chief species; birches, maples, and poplars grow in large numbers.

Economy Series (23,764 acres)

Economy soils are distributed from Springhill to Chignecto Bay and Apple River. They occupy poorly drained level or gently sloping sites in association with Shulie and Springhill soils, and they are derived from the same shallow, stony glacial till containing gray sandstones. Their poor and very poor internal drainage results chiefly from their topographic position, often in conjunction with shallow bedrock. Consequently, the soils are saturated for much of the year in addition to being very stony and extremely acid.

The surface is covered by hydromor, up to 6 inches of moderately or poorly decomposed remnants of herbaceous plants, mosses, and hardwood and softwood litter. This rests on a pale gray Aeg horizon of sandy loam or loamy sand texture and weak platy structure. Patchy organic staining may penetrate several inches from the surface. The base of this horizon is distinctly mottled with yellow, and faint dark gray and yellowish mottles may extend throughout.

Beneath, at a depth of 6 to 10 inches, lies a grayish brown, brown, or reddish brown B horizon with prominent or distinct mottles extending deeper than in the associated Springhill soils; the matrix color differs little from that of the underlying parent material. The horizon may or may not possess a fragipan character as in the Springhill soils, but never exhibits a B horizon of iron accumulation. The parent material is grayish brown or brown and the many stones and pebbles it contains are chiefly coarse gray sandstone.

Use

Virtually all the Economy soils in Cumberland County are of little use for agriculture because of their wetness, stoniness, and acidity. They are also rated low in productivity for forestry.

Falmouth Series (4,775 acres)

Falmouth soils are associated with Queens soils in the area between Malagash and Wallace, between Oxford Junction and Thomson Station, and in one or two other small areas. They occur on the gently sloping tops and moderately sloping sides of broad east–west ridges, which permit adequate surface drainage and moderately good soil drainage. The soils are moderately fine textured and acid and were formed on a neutral to weakly calcareous glacial till of sandy clay loam texture, which was derived from gray and red sandstones, shales, and mudstones of the Carboniferous age.

The plow layer on cultivated Falmouth soils is a brown loam or sandy clay loam. Under forest the surface is generally covered by about 4 inches of moder humus, which may be partially incorporated in the mineral soil to form a thin dark-colored Ah horizon. The bleached Ae horizon is 1 to 5 inches thick and of sandy loam to sandy clay loam texture. A very thin weakly developed friable B horizon of Fe and Al accumulation merges into a firm compact horizon from 10 to 25 inches thick into which clay particles have been washed and deposited in films. The change to the unaltered material of the C horizon is barely perceptible because the color is the same. There is a gradual increase in pH with depth to a value of 7 at 3 to 4 ft. Some profiles are moderately gravelly and stony. The bulk density of the compact B and C horizons is between 1.8 and 2.0 g/cc and they are only slowly permeable.

Falmouth soils can be regarded as Queens soils in which local factors such as slope and greater soil porosity have aided drainage. In Cumberland County they are closely related to Pugwash soils because their clay content rarely exceeds 20 to 22%.

Use

Although the Falmouth soils are somewhat superior to Queens soils from a natural drainage standpoint, there is much neglected farmland that is suffering the same fate of reversion to forest. Large areas remain under poor-quality, second-growth forest of spruce, birches, and maples. Where cultivated the soils are useful for growing hay and cereal grains, but, like the Queens soils, they are slow to warm up in the spring and can be improved by artificial drainage. Fairly large amounts of surface stone on some areas, such as west of Thomson Station, may have caused some of the soils to be left under forest. Otherwise, they have a good potential for agriculture providing adequate fertilizers and lime are applied to the soil.

Hansford Series (19,075 acres)

Hansford soils extend in an irregular belt from Conns Mills (Fig. 5) to west of Oxford on land that is undulating or gently rolling. They are well to rapidly drained sandy loams on glacial till derived from Carboniferous gray, brown, and red sandstones, and contain large amounts of pebbles and small cobbles.

Undisturbed profiles have a few inches of mor or moder humus resting upon a prominent leached horizon of extremely acid sandy loam or loamy sand, about 4

inches thick. The B horizon consists of highly porous friable soil of similar texture, distinguished by its strong brown or yellowish red color. The bright coloring weakens downwards to the unaltered parent material at 20 to 25 inches, which is characterized by paler yellowish red or reddish brown colors and a gravelly sandy loam texture. Gravel and cobbles in the profile serve to maintain the permeability and a loose open structure in materials that otherwise tend to be quite compact. The cultivated soils have a plow layer of brown sandy loam and suffer moisture deficiencies in middle and late summer.

In many marginal areas the Hansford soils are difficult to distinguish from Pugwash soils, but their lower horizons are grayer or yellower, less compact, and contain greater amounts of pebbles and small cobbles.

At several places between Hansford and Conns Mills and flanking the Wallace River at Lower Wentworth, the parent material appears to be weakly stratified and may be an outwash deposit. The soils are very similar in appearance to Hebert soils.

Use

Most of the Hansford soils are too stony or cobbly for agriculture, and only a small acreage has been cleared. These soils have a low water-holding capacity and when farmed tend to be rather droughty. They contain low levels of organic matter. Many of the farms are part-time marginal operations, used for growing hay and oats, and occasionally potatoes. Many fields are left in poor-quality permanent pasture.

The forests have been heavily exploited in the past and are of poor quality at the present time, with many open stands on the drier areas. Red and white spruce are the chief species, and there are many birches, maples, and pines.

Hebert Series (27,937 acres)

The strongly leached Hebert soils are scattered throughout the County on sands and gravels laid down at the close of the Ice Age by torrential meltwaters. Their main concentrations are in the valleys leaving the Cobequid Mountains where they extend far out into the Cumberland Plain and on the Parrsboro coastal plain. Fingers of Hebert material extend back into the hill valleys, where it tends to be coarser. The topography may be very gently sloping and smooth or moderately rolling and quite rugged, depending upon the mode of deposition of the sands and gravels. They have been deposited in valley trains, old river terraces, outwash deltas, eskers, and kames, and some of these have been modified by later stream and marine action.

The parent materials of the Hebert soils contain the full range of rock types in the County, but the more resistant rocks of the Cobequid Mountains predominate. The soils have a loose open strucure, coarse texture, rapid natural drainage, and consequent problems of droughtiness. The droughtiness is reflected in the greater frequency of pines in the forest, which in some areas grow in pure stands.

A typical undisturbed Hebert profile has 2 inches of acid mor humus resting on a deep-leached horizon that occasionally extends to 14 inches. It is frequently devoid of clay and ranges from pure silica sand to a sandy loam. The plow layer on such material may be grayish brown or dark brown depending on the amount of residual incorporated organic matter, which over large areas is quite low. The parent material is generally reddish brown or yellowish red; these colors partly mask a well-developed B horizon enriched in Fe, Al, and some colloidal organic

matter (Bfh). Structural aggregation, although best in this horizon, is never strongly developed at any level in Hebert soils. Cementation by mobile iron oxides is sometimes found in the B horizon. Coarse gravel may be virtually absent or may dominate the whole soil profile, but there are very few Hebert soils that are not underlain at some depth by gravel beds. A sandy or loamy plow layer frequently rests directly on gravelly material.

The more gravelly Hebert soils typically display a wide variation in the proportion of fine-earth matrix, both over short distances laterally and down the profile. Investigation of some cobble soils on steeper slopes in the hills, which were previously mapped as Hebert soils, disclosed that they were probably slumped or colluvial materials on glacial till. Furthermore, no logical reason was found for maintaining the separate Parrsboro Series, and these coarse gravelly outwash soils are now included in the Hebert Series.

The boundaries of Hebert soils, normally quite sharply defined, are difficult to delineate where they merge into Cumberland soils in some of the valleys extending northward from the Cobequid Mountains. Resting on recent sediments, the Cumberland soils are young and exhibit little horizon development, but there are intergrade soils on the older sediments in which leaching has produced incipient horizons. The presence of a recognizable podzolic B horizon puts these soils into the Hebert Series. In other areas, notable around Conns Mills and Hansford, Hebert soils pass very gradually into Hansford soils. The adjacent glacial till has the appearance of being water-worked.

Use

Hebert soils in a few narrow strips in the central part of the County and over larger areas around Parrsboro have been cultivated, but, apart from a few specially favored situations, they are incapable of holding sufficient moisture to sustain crops through the summer. They are also extremely acid and infertile, and require very heavy applications of lime and fertilizers. There is some potential for growing potatoes and a variety of fruit and vegetables with the aid of irrigation. Stones are rarely a serious problem on Hebert soils.

At present the bulk of the Hebert soils are under poor-quality second-growth forest of red spruce, red pine, and jack pine, with some birches and firs.

Joggins Series (11,646 acres)

Joggins soils are grayish brown, moderately stony and moderately fine textured and have poor internal drainage. They are located mainly in two districts, one around the village of Joggins and the second on the Parrsboro coastal plain. The glacial till upon which they have formed is a grayish silty clay loam derived from the fine-grained red and gray sandstones, shales, and mudstones of Carboniferous coal measures beds. The soils generally show evidence of clay migration to the B horizon.

A variety of humus forms on the forest floor includes raw moder, hydromor, and peaty mor in various stages of decomposition. The A horizon is typically a pale gray or pale brown sandy loam or sandy clay loam, exhibiting conspicuous yellowish mottling indicative of prolonged saturation and gleying. The horizon is 6 inches deep or more. When cultivated these soils puddle easily and bake hard upon drying. Beneath the A horizon are 4 to 10 inches of very intensely mottled material in which the yellowish and reddish mottles dominate a dull brown matrix. Soft black

concretions of MnO_2 are a common feature of this and the underlying layer. The texture is generally finer than in the overlying horizon, and there appears to be considerable accumulation of free Fe. This horizon remains saturated for long periods after heavy rainfalls.

The remainder of the B horizon, commencing at a depth of about 12 inches and extending to 24 inches, is dense and compact sandy clay loam in which the mottling diminishes and the matrix assumes brown or dark grayish brown colors. Thin films of translocated clay line many of the voids, which are not plentiful on account of the poor structural development. In some Joggins soils this layer constitutes a fragipan and possesses the characteristic vertical gray fracture planes and a coarse platy structure. Inevitably such material is very slowly permeable and so is the underlying C horizon. The C horizon is clayey, dense, and colored dull reddish brown or grayish brown, with very few mottles. Black fragments of coal and manganiferous sandstone are found in the till.

The A and B horizons are extremely acid, with the lowest pH values at the surface. There are moderate amounts of stone throughout the profile and the glacial till is frequently shallow to bedrock.

The surface of Joggins soils ranges widely in texture. In a few areas Joggins soils are of more reddish hue especially in the C horizon, but they possess all the other characteristics of the Series.

Use

Joggins soils have little value for agriculture, apart from limited use as pasture. Their chief drawback is the very dense subsurface layers that cause prolonged saturation. This is difficult and uneconomic to correct by artificial drainage because the material has a very low hydraulic conductivity. Stoniness is not as serious as on the associated Diligence soils, but it remains a moderate limitation for agricultural use. The soils are extremely acid.

Some areas around Joggins and Parrsboro are cultivated on a small scale, and there are a few run-down farms elsewhere on these soils. About 90% of the Joggins soils support forest, mostly scrubby second growth of firs and spruce, with some maple, birch, and poplar.

Kingsville Series (10,223 acres)

Kingsville soils are distributed irregularly over the Cumberland Plain in association with the related Queens soils. Sizeable areas occur east of the Wallace River to the county line and between Springhill and Amherst. They are poorly drained, moderately fine-textured soils on gently sloping land and in shallow basins subject to restricted surface drainage. The parent material is a reddish brown sandy clay loam glacial till derived from Carboniferous shales, mudstones, and fine-grained sandstones, including some calcareous material. The forest cover reflects the wet soil conditions that prevail for much of the year. Black spruce and tamarack are prominent in the forests of red and white spruce and firs, and stands are of poor quality and often stunted. Under an open forest canopy the hydrophytic ground flora abounds in such species as sphagnum and hypnum mosses, kalmia, and Labrador tea. The soils are dense and intensively gleyed, and moderate amounts of clay have been translocated from the A to the B horizon.

Wet acid conditions permit little biological activity and only slow decomposition of the mor humus so that it often accumulates to a depth of 6 inches or more

depending upon the proportion of mosses. Intense leaching has produced a pale gray Ae horizon of sandy loam texture with diffuse pale yellowish mottles in its lower part. It is normally 8 or 10 inches thick, but many of the Kingsville soils in the area are marginal to Queens soils or have been eroded and their Ae horizons are less conspicuous. Underneath there is an intensively mottled 6- to 8-inch B horizon of reddish brown, dark brown, and yellowish brown color, which in some profiles is enriched with hydrated Fe but not Al. Its content of organic matter varies, but only a modest amount coating the mineral grains can substantially darken the horizon. Where paler colors prevail, the horizon may be regarded as a transitional ABg horizon. In some profiles the texture is similar to that of the horizon above, but a somewhat higher clay content is more usual. This horizon is quite porous and permeable, but it passes abruptly into a very dense, impermeable clay loam, extending to depth.

Superficially, the dense material at a depth of 1 to 2 ft is indistinguishable from the parent material because of similar texture and color. But many of its fine voids are plugged with thin films of clay washed in from above. Mottles are apparent in the upper 12 inches, but often they are only faint, being masked to some extent by the reddish color of the material. Accompanying soft black concretions of MnO_2 are a further indication of poor aeration.

Kingsville soils are strongly acid, with pH values of 4 to 4.5 in the Ae horizon and 5 to 5.5 in the B horizon, but they generally reach 7 at a depth of 48 inches, where free $CaCO_3$ is detectable in the parent material.

Water percolated through cores of the surface soil at the rate of 4.7 inches/hr, but the rates were only 0.1 and 0.3 inch/hr at depths of 15 and 30 inches.

Individual soils vary slightly in some characteristics. In some a 2-inch layer of dark organic staining in the base of the Ae horizon might be regarded as an incipient Bh horizon. Humus is also incorporated in the surface of some Kingsville soils to produce a dark grayish brown mull-like Ah layer. The plow surface on Kingsville soils is usually medium brown.

The clay films, although a common feature of the B horizon, are rarely well developed or numerous in the typically dense matrix. Kingsville soils are not particularly stony, but in some areas the profile contains up to 20% by volume of large stones and cobbles of sandstone. In some areas in the western part of the County, parent materials are a darker brown color.

Kingsville soils grade into Masstown soils where the clay content of the parent material falls below 20%; then sandy clay loams give way to sandy loams and loams. The less poorly drained Kingsville soils, of which there are many, merge into Queens soils; Kingsville soils were formerly included in the Queens Association.

Use

The forests on Kingsville soils have been heavily exploited in the past and are in a poor condition today. These wet soils do not provide good conditions for tree growth and give a decided advantage to tolerant species, as mentioned earlier. Very few of the Kingsville soils have been cleared and drained for agriculture. Artificial drainage encounters such problems as the low hydraulic conductivity of the soil, shallow and indeterminate gradients with poor outfall, and large volumes of water running off the surrounding higher ground; there is little prospect of a return on the investment. Some Kingsville soils yield crops of hay and support a few areas of pasture, but they cannot be regarded as useful agricultural soils.

Kirkhill Series (47,027 acres)

Kirkhill soils are in a belt 2 to 3 miles wide extending along the southerly rim of the Cobequid Mountains from Advocate to the county line near Five Islands. The rolling upland is deeply dissected by the valleys of short streams descending to the Minas Basin, to produce some of the most rugged terrain in the County. Gray shale bedrock is close to the surface everywhere. Although the soil parent material might be regarded as a mantle of glacial till, it is very thin and barely distinguishable from the weathered bedrock. The brown, well-drained acid loams developed on this gray material are marked by a high content of shaly gravel.

Forested soils have a 2- to 4-inch layer of raw moder resting on an eluviated horizon (Ae) that is only partially leached. Plowing turns up some of the underlying loam to which organic matter and Fe have imparted a dark reddish brown color, resulting in a medium brown soil to plow depth. The middle and lower B horizons are marked by a transition from reddish brown to yellowish colors, a decline in soil structural development, and a gradual increase in the amount of soft shaly gravel. The fine earth (particles less than 2 mm) is of loamy texture, usually with a high content of silt. Yellowish brown mottles are common in the subsoil. In some areas they are symptomatic of imperfect drainage and poor aeration, but more often the aeration is adequate and they are simply produced by the weathering of a naturally gray material rich in Fe.

There is generally a fairly sharp boundary at the unaltered parent material, which is an olive gray colored shale containing very little fine earth. On the steeper

Fig. 12. Blueberry field and stone piles on the shallow and steep Kirkhill soils, overlooking a gravelly outwash plain and the Bay of Fundy at Parrsboro.

slopes, characteristic of much of the Kirkhill area, soil creep has prevented development of a distinct sequence of horizons. Slope mixing has produced a fairly uniform brown or olive brown soil.

In the area east of Parrsboro and around Spencers Island, the soils have more body. A higher clay content and lower gravel content are accompanied by some deterioration in the drainage status of the soils. Some of the surface organic matter has been biologically incorporated into the top 3 inches of mineral soil to produce a dark brown Ah or Ahe horizon. These Kirkhill soils are transitional to the Diligence soils.

Use

The forests on the Kirkhill soils have been subjected to intensive lumbering since the early days of shipbuilding on the shores of Minas Basin. The climate of the Fundy coast favors balsam fir and red spruce; sugar maple, red maple, and birches are secondary species. Some of the gentler sloping areas have been cultivated in the past, and some former hay and pasture land is finding better use in blueberry production. In a few areas where topography is no problem, acidity and stoniness are the chief limitations on normal agricultural use, whereas a few more gravelly soils suffer from droughtiness in summer.

Masstown Series (62,723 acres)

Masstown soils are distributed over the northern part of the County, in valleys and on gently sloping land where surface drainage is slow and indeterminate. The largest block is in the triangle bounded by Amherst, Tidnish, and Shinimicas; other areas occur near Maccan, between Shinimicas and River Philip, and around the Wallace River estuary and Middleboro. The soil parent material is a very compact sandy loam glacial till, derived chiefly from reddish Carboniferous sandstones. The slow surface drainage, the compactness of the till, and a fragipan share responsibility for the poor or very poor natural drainage within these soils. They remain more or less saturated for long periods in the year. Masstown soils are the poorly drained equivalents of the Debert soils.

On undisturbed sites, 3 to 6 inches of mor humus overlies a bleached A horizon of pale gray or pale brown sandy loam, up to 10 inches thick. This is 2 to 3 inches thicker than on neighboring areas with better drainage. The lower part contains diffuse yellowish mottles, which become very prominent in the top few inches of the B horizon. This is a reddish brown sandy loam, which lacks podzolic enrichment with Fe and humus. The underlying compact B horizon extends to a depth of 2 ft or more and differs little from the parent material except that it is faintly mottled, contains some black manganiferous concretions, and has definite fragipan characteristics. Its coarse platy structure and network of vertical fracture planes are not as well developed as in the Debert soils. The sandy loam C horizon is reddish brown to dark red and is weakly calcareous at depth, frequently with a pH value of 7 at 3 to 4 ft.

The very compact subsoil effectively resists penetration of water and plant roots, and rainwater is forced to move laterally over it where the slope permits. Holes dug in these soils are filled with water running out of the surface soil from a perched water table. A ground water table makes a contribution in some level areas. The surface layers of these soils commonly dry out for considerable periods in summer.

Work on undisturbed soil cores in the laboratory has shown that 1 inch of rainfall percolates through the soil of the A horizon in 20 min and through the upper B horizon in 2 hr. It takes 4 days to pass through the material at the 24-inch depth. Equivalent bulk densities were 0.98 g/cc for the A horizon, 1.63 for the upper B, and 1.95 at 20 inches.

The texture of the Aeg horizon ranges from loamy sand to silt loam; the finer textures are a product of very intense weathering. In many Masstown soils the layer of most intense mottling at 10 to 15 inches possesses characteristics of both A and B horizons and is best described as an ABg horizon. Fissures and tongues in the upper B are frequently filled with Aeg material. Reducing conditions are presumed to extend to some depth in the B horizon, but their morphological expression is limited by the overall reddish color of the material and lack of organic matter, which plays an important role in gleying.

Use

The wetness of Masstown soils is a severe limitation on their use for agriculture, and in most areas prohibits it. Improvement demands quite comprehensive systems of artificial drainage; although these are feasible on some sloping land, they would run into excessive capital outlay on many of the broad depressions where there is sluggish drainage outfall. Very poorly drained areas, where standing water is normally unable to escape, can benefit from major drainage ditches. Only a small portion of the soils are now cleared, and these are used for pasture and occasional hay crops. The drainage status of these soils is better than in similar soils under forest vegetation, but the sward is of poor quality and frequently is infested with mosses and sedges. Upgrading of these soils requires heavy applications of lime and fertilizers in addition to artifical drainage. Such measures might be worthwhile on some narrow swales of Masstown soils, which break up better-drained areas into units too small for efficient farming. Stoniness is rarely a serious limitation on these soils.

Most of the Masstown soils are under forests of black, red, and white spruce, and balsam fir mixed with tamarack, birches, and poplars. In many areas the trees are stunted, and elsewhere extensive exploitation has left the forest in poor-quality second growth.

Millar Series (2,078 acres)

A few small areas of wet sandy soils, the largest of them being on the level valley floor north of Newville Lake, have been placed in the Millar Series. They are the poorly drained equivalents of Hebert soils and have developed on glaciofluvial outwash sands with high water tables.

Millar soils may have a weakly podzolic sequence of horizons, with a fairly thick pale gray Ae horizon over a thin iron-enriched B horizon, resting upon reddish brown and dark reddish brown stratified sands and gravels. More often there is little horizon development below the Ae. Virtually the whole profile is gleyed with prominent mottling confined mainly to the B horizon. Coarse sand predominates at all levels, but some of the soils have a sandy loam texture; many soils contain gravel lenses several inches thick.

Use

The soils are at present under a scrubby growth of birches, maples, and softwood species. They are too wet and infertile for agricultural use, and effective drainage would require control of the high water table over wide areas. The soils have a low potential for agriculture.

Pugwash Series (47,515 acres)

Areas of Pugwash soils are distributed throughout the Cumberland Plain. Their topography is undulating to gently rolling, and the low smooth ridges on which many of these soils are found provide fairly good surface drainage and good to moderately good soil drainage. The soil parent material is a reddish brown glacial till of sandy loam to loam texture in which the chief constituents are red and gray Carboniferous sandstones and shales. Large acreages of these important agricultural soils are cleared.

Pugwash soils are extremely acid, but the underlying till is frequently weakly calcareous at around 4 ft. Surface and profile stoniness is negligible over three-quarters of the area, but would be a severe limitation to agricultural use on the remainder.

Cultivated soils have a reddish brown or brown plow layer of sandy loam or loam texture. Undisturbed soils under woodland have 4 to 8 inches of leached sandy loam or loam beneath 3 or 4 inches of mor or moder humus. This rests upon a porous, friable, and somewhat fluffy Bf horizon of yellowish red color and a more compact lower B horizon. Plant roots generally have little difficulty penetrating to 18 inches. The lower B horizon exhibits many of the fragipan features described under the Debert Series, related imperfectly drained soils, but they are less strongly developed and occur somewhat deeper in the profile.

The clay content of Pugwash soils ranges from 5 to 20% and for most of them it is over 10%. When the clay content approaches 20% in the C horizon, the soils grade into the Queens Series. Where the clay content is low and the subsoil is redder and micaceous, Pugwash soils merge into the Tormentine Series, and in many areas the distinction is difficult to make. In the Oxford area and westwards, there are increased amounts of gray sandstone accompanied by browner subsoils, indicative of a transition to Shulie and Hansford soils. Moderately well drained Pugwash soils may be mottled at the junction of the A and B horizons, and they pass into the imperfectly drained Debert soils when this is accompanied by virtual disappearance of the podzolic Bf horizon.

The Pugwash Series as defined here includes only the well and moderately well drained members of the Pugwash Association on older maps. The imperfectly and poorly drained members have been placed in the Debert and Masstown series.

Use

Most of the Pugwash soils have been cleared at some time and stone piles in some of the pastures attest to the amount of stone removed from the fields in the past. The present forested area supports scrubby second-growth red and white spruce, birches, and maples.

Pugwash soils are among the most valuable for agriculture. Elaborate systems of artificial drainage are not necessary, but stoniness is a serious problem on 25% of the area. The soils are easy to work, but in some areas they may be a little later to

warm up than the Tormentine soils. Broken topography is a moderate limitation in some areas. Generous applications of lime and fertilizers are essential for good crop yields. Much of the land should be consolidated into larger field units. At present the crops are chiefly forage and feed grains, in a predominantly livestock farming system. The soil is suitable for corn and potatoes, but only limited acreages are grown. Marketing difficulties and the division of the land into small units are two of the factors that have prevented the development of the full potential of these soils.

Queens Series (75,702 acres)

Queens soils, occupying over 7% of the land area, cover undulating and gently rolling topography in the eastern part of the Cumberland Plain; much of the land is in long broad east-west ridges. The soils extend in an almost continuous belt from Springhill through Oxford, Street Ridge, and Wallace to the Malagash Peninsula. There is also a substantial acreage around Pugwash Junction. These moderately fine-textured acid soils have developed on neutral and weakly calcareous glacial till of sandy clay loam texture. This till was derived from gray and red sandstones, shales, mudstones, and limestones of Carboniferous age. Although the topography generally permits fairly good surface drainage, the dense fabric and fine texture of the subsoil allow only imperfect internal drainage.

Cultivated Queens soils have a brown loam surface. Undisturbed forest soils support a variety of humus forms, about 4 inches thick, in which the semidecomposed F layer is usually prominent. The pale colored leached horizon (Ae) ranges in texture from sandy loam to sandy clay loam and is usually about 5 inches thick. It is faintly mottled as a result of the wet gleying conditions that persist at least through the winter and spring months. Although Fe and Al have been leached from the A horizon, little has been precipitated in the B horizon, where the main accumulation product has been fine clay. Some of it occurs as thin clay films coating the few voids in the dense matrix. The bulk density of the material in the B and C horizons is about 2 g/cc and the clay content of 20% or higher gives textures of sandy clay loam or clay loam.

The B and C horizons are reddish brown with distinct yellowish mottling in the upper B horizon and numerous fine soft black specks of MnO_2. The pH values increase with depth. The B horizon frequently possesses fine grayish vertical fracture planes, but these and other fragipan features are weakly developed, as they appear to be wherever the clay content exceeds 15 to 17%. The soils are moderately stony, but surface stoniness is a severe hindrance to farming in less than 5% of the area; in some areas there is evidence of considerable clearing of stone from fields in the past.

Coarser-textured Queens soils intergrade to the Debert soils in which a clay content of less than 18% is the only significant difference; the dividing line is so ill defined as to be rather arbitrary in many areas, for instance east of Oxford. Along their southern margin in the County coarser-textured Queens soils contain some conglomerate and sandstone gravel as they grade into Westbrook and Hansford soils.

The reddish brown color of the parent material is a fairly consistent feature, but redder materials are found in some easterly areas formerly mapped as Nappan soils, which are now included in the Queens Series. In the west, grayer colored Queens soils represent an intergrade to the Diligence and Joggins series. On gently

sloping sites and in depressions Queens soils grade into the poorly drained Kingsville soils, which have more prominent mottling and a thicker Ae horizon.

Use

Cleared land is used chiefly for hay and pasture; in some areas barley and oats are grown. Neglected pastures in various stages of reversion to forest, with white spruce the main colonizing species, are a common sight on Queens soils. Large areas presently under forest were formerly farmed. Older forested land supports a mixture of hardwoods and softwoods in which red spruce is the commonest species. Because of its accessibility the forest has been extensively cut over and includes a lot of poor-quality scrubby growth.

The soils are worked with some difficulty. The range of water content in which they can be worked is narrow compared with other soils in the County. Where the surface layer is a sandy clay loam, it puddles easily and plowing in the sticky wet stage produces clods that turn very hard upon drying. The combination of naturally imperfect drainage, slowly permeable subsoil, and fine texture makes the Queens soils slow to warm up in the spring. Cultivation and plant growth are generally 1 to 3 weeks later than on other agricultural soils. It is unlikely that tiling can be an economic method of improving soil drainage in these soils, because of the density and low hydraulic conductivity of the subsoil.

Rodney Series (85,199 acres)

Nearly all the Rodney soils are distributed in a belt 2 to 4 miles wide bordering the Cobequid Mountains from Westchester in the east, through Windham Hill, Mapleton, and Chignecto game sanctuary, with an offshoot around Apple River in the west. This is mostly rolling forested land, which is quite rugged in places and frequently attains elevations of 500 ft above sea level. The soils are acid, well drained, and coarse-textured and are mostly sufficiently stony to prevent agricultural use. They have formed on fairly gravelly sandy loam glacial till, which is largely derived from the underlying gray Carboniferous sandstones and significant proportions of conglomerate and crystalline rocks.

The forest floor has 2 to 4 inches of felty mor humus with only an incipient humified layer and very little mixing of mineral grains. The uppermost mineral layer (Ae) is a very pale brown or reddish brown loose sandy loam, 3 to 6 inches thick. The plow layer on cultivated land is dark brown. Beneath the Ae is 5 to 10 inches of mellow bright yellowish red sandy loam or gravelly sandy loam, which is very porous and granular. At a depth of about 12 inches this grades into fairly compact reddish brown material, which has a weak blocky structure and is usually quite gravelly. This material grades imperceptibly into a reddish or grayish brown, gravelly parent material at depths of 15 to 24 inches, or deeper on some sites. The texture is sandy loam to loam. The whole profile frequently contains up to 25% by volume of stones and occasionally much more.

A thin fragipan was noted at a number of localities, but it is not a general feature of the Rodney soils. In a few depressions and seepage spots the natural drainage is impeded, resulting in mottling in the upper B horizon. Only a few of these areas were large enough to be differentiated on the map and were placed in the Debert Series.

The boundaries separating Rodney soils from adjoining Westbrook, Wyvern, Shulie, and Hansford soils are not distinct. A broad gradation to Wyvern soils is

Fig. 13. Rolling areas of Rodney soil under blueberries and forest, with Hebert and Cumberland soils on the valley train gravels and alluvium, Collingwood.

expressed in a higher granite content, greater accumulation of organic matter in the B horizon, and a somewhat thinner leached surface horizon. The Shulie soils lack crystalline rocks and have an overall grayer color, even though reddish material is frequently encountered in the subsoil. Hansford soils are of similar color but are less stony and devoid of conglomerate rock. In the distinctive reddish brown Westbrook soils, conglomerates are dominant; there is little admixture of other rock types.

The Rodney Series as presently defined includes all the soils formerly placed in the Southampton Association, because the difference is inconsequential.

Use

A few small areas of Rodney soil adjacent to roads are cleared and used for hay and pasture. Their value is limited by stoniness, liability to soil erosion, lack of fertility, and some shallowness. Their extreme acidity demands heavy applications of lime. The remainder of Rodney soils support forest, much of which was heavily exploited in the past, resulting in poor-quality stands today particularly in the eastern part of the soil area. There are areas west of the Parrsboro Gap supporting fairly good stands of red spruce and balsam fir. Spruce, fir, and maples are the chief species, but in the area west of Greenville Station there are extensive pure stands of jack pine and white pine.

Rossway Series (2,378 acres)

In Cumberland County the Rossway soils are virtually confined to the strongly rolling headland of Cape d'Or and Cape Spencer, which rises steeply from sea level to 500 ft. The soil parent material is a thin, cobbly glacial till of sandy loam to loam texture derived from the underlying Triassic basalt but containing small amounts of sandstone. It is a brown color and the soils are well-drained brown sandy loams.

Active biological breakdown of the forest humus has produced a mull-like moder, which is frequently sufficiently incorporated in the mineral soil to replace the incipient Ae layer with 2 to 3 inches of brown Ah material. This material rests on a yellowish brown sandy loam or loam with a moderate level of organic matter that has contributed to a mellow, granular or fine blocky structure. Unaltered parent material is encountered at depths of 24 inches or less.

The soil tends to be slightly redder than Rossway soils described elsewhere in the province; parent material colors range from brown to reddish brown. The difference does not warrant separate recognition, and so in this survey the former designation as Spencer soils has been abandoned.

Use

Rough topography, excessive stoniness, and shallowness have prevented agricultural use of the Rossway soils. But they have a somewhat higher nutrient status than many upland soils, and when not too shallow provide a good rooting medium for trees. There are good stands of spruce and fir, but climatic exposure is a serious limitation on much of this area.

Shulie Series (107,807 acres)

Shulie soils, covering about 10% of the County, are second only to the Debert soils in extent. They occupy undulating to gently rolling country in the western part of the Cumberland Plain from Apple River to the Springhill area. These soils are found on a brown to reddish brown, coarse-textured and stony glacial till in which hard, coarse-grained gray sandstones of Carboniferous age are prominent. The till is quite shallow, especially west of River Hebert where bedrock exposures frequently exert a strong influence on the topography and surface drainage. Most of the area is forested; red spruce, balsam fir, maples, and birches are the chief species. The soils are well to moderately well drained, fairly shallow, and strongly acid.

Undisturbed Shulie soils have about 4 inches of mor humus and a fairly shallow, strongly acid leached layer of coarse sandy loam over a friable strong brown horizon of similar texture (Bfh). The lower B horizon beneath may be quite compact, but for the most part an abundance of gravel and cobble keeps the soils open and allows the water to move freely. The C horizon at a depth of 24 inches or more is typically brown or grayish brown, but in many places red sandstones impart a redder hue. This is especially noticeable in the north where Shulie soils grade into Pugwash and Debert soils. On cultivated land, the plow layer is a medium brown sandy loam with between 4 and 6% organic matter.

In addition to the tendency of some Shulie soils to be somewhat redder than normal, a markedly different reddish brown sandy clay loam substratum was observed at several widely separated localities. This material may underlie many of the soils at depth and has the appearance of ground moraine on which the Shulie

Fig. 14. Stony Shulie soils in an old burned area, upper River Hebert.

parent material was laid as ablation moraine. In a few localities where the finer-textured material comes to within 2 ft of the surface, the soil is imperfectly drained and was placed in the Queens Series.

West of River Hebert, where there are large areas of very shallow soils, the sequence of horizons is similar to that described, but individual horizons are much thinner. The haphazard interference of bedrock with soil drainage creates an intricate pattern of imperfectly and poorly drained depressions, which are inseparable on a 1:63,360 scale map but occupy too large a total area to be ignored. These appear on the map as a complex mapping unit in which the approximate percentage of the Shulie soils and their imperfectly and poorly drained associates (Springhill and Economy series respectively) are included in a map symbol. These associates, unlike the Shulie soils, exhibit a mottled color distribution in some part of the profile and lack a friable Bfh horizon. A few areas, where the till is very shallow and solid bedrock forms most of the land surface, appear on the map as Rocky Land.

Use

Very few of the Shulie soils have been cleared for agricultural use because of their stony surfaces; most of the existing hayfields and pastures were originally brought into use only after extensive removal of stones. On these fields very heavy applications of lime and fertilizers are necessary, because the soil is as acid and infertile as any in the County.

On the deeper Shulie soils, the forests contain fairly good stands of red spruce,

maple, fir, and hemlock, but their relative accessibility resulted in fairly intensive exploitation in the past. Second growth includes many maples, birches, and poplars. The shallow soils support poor-quality forests of red spruce, black spruce, fir, maple, birch, pines, and hemlock, which frequently grow in open stands. The establishment of forest vegetation is slow in many of these areas where fires have created barrens.

Springhill Series (35,796 acres)

Springhill soils are found on the western Cumberland Plain, especially bordering the Chignecto Bay southwest of Joggins; north and east of River Hebert village; south and east of Maccan; and to the north of Springhill. They are stony, imperfectly drained soils that have developed on a thin glacial till blanket, through which solid rock strata exert a strong influence on the undulating to gently rolling relief. Hard gray sandstone is prominent in the till, but other Carboniferous sandstones, many of reddish brown color, are present in varying amounts.

The land surface on Springhill soils is very stony. Under forest there is a 4-inch layer of mor or moder composed mainly of semidecomposed softwood needles and mosses (F layer). This layer rests on bleached loamy sand or sandy loam up to 10 inches deep, which has a weak platy structure but loose consistence and is extremely acid. The pale gray matrix is mottled with yellow toward the bottom of the horizon.

The gray material passes into a brown or reddish brown sandy loam B horizon, which is commonly very compact and possesses the platy structure and vertical gray fracture planes of a fragipan. These features are described fully under the Debert Series. A very thin podzolic B horizon enriched with Fe and distinguished by its strong brown color may be present. A dark layer of colloidal humus precipitated with the Fe was noted in several profiles, but this was no more than 2 to 3 inches thick. The fragipan is not always present, possibly due to a high content of gravel and flaggy sandstone, and in these less compact Springhill soils the imperfect drainage results from other factors, such as topography or bedrock close to the surface. The B horizon, with or without a fragipan, visibly differs little from the C horizon, but in some localities there is a lithologic color change to redder material with a markedly higher clay content at a depth of about 3 ft. This may represent ablation moraine resting on ground moraine.

The textural range of Springhill soils is from loamy sand to gravelly loam, but 80% of them are sandy loams, gravelly or otherwise. The better-drained soils merge upslope into the Shulie Series, soils with a substantial podzolic B horizon; the poorly drained counterpart is the Economy Series, marked by more intensive and deeper gleying and mottling.

All three series were included in the Shulie Association in the earlier Cumberland report (36) and because of their intricate pattern on the ground, it was impossible to delineate them separately on many parts of the present soil map. In some of these instances a complex mapping unit is labeled with the approximate percentage of each series included.

Use

Almost all of the Springhill soils are of little agricultural use on account of stoniness and imperfect drainage. They are mostly under scrubby forest of spruce and fir, along with birches and a thick herbaceous understory on some areas that have suffered from forest fires.

Tormentine Series (26,728 acres)

Tormentine soils are among the best agricultural soils in the County. They are scattered across undulating to gently rolling topography bordering the Northumberland Strait from Tidnish to Pugwash and at a few places inland. They are well-drained fine sandy loams developed on a reddish brown to red glacial till in which soft red micaceous sandstones of Permo-Carboniferous age are the chief consitituents.

Although the glacial till is weakly calcareous and the pH approaches 7 at a depth of 4 ft, the solum is moderately to strongly acid. Internal drainage, because of the compactness of the subsoil, is not as rapid as might be expected in a coarse-textured soil. However, the topography permits fairly rapid surface drainage. Surface stoniness is negligible and only moderate amounts of stone with considerable gravel may be encountered in the soil profile.

The undisturbed soils under woodland exhibit a bleached Ae horizon directly beneath the forest litter, which rarely exceeds 4 inches in thickness. It commonly retains a slight reddish hue. This rests on a porous, friable, and somewhat fluffy Bfh or Bf horizon and a more compact lower B horizon, both of sandy loam texture. However, plant roots usually have little difficulty penetrating to 20 inches. These features distinguish the soil from the associated, imperfectly drained Debert soils.

The parent material is typically red, but in many Tormentine soils, especially where they grade into Pugwash soils, it is reddish brown or dark red. Fine flakes of mica are a consistent aid to the recognition of these soils.

Fig. 15. Tormentine soils at Shinimecas Bridge.

The compact B and C horizons frequently have a platy structure and grayish vertical fracture planes, but on the whole these fragipan characteristics are only weakly expressed. The compact subsoil markedly retards the passage of water. In the laboratory the vertical hydraulic conductivity of the Ae horizon in an undisturbed soil was an adequate 1 inch of water/hr and up to 12 inches in the friable Bfh horizon. It dropped to 0.2 inch/hr in the lower B horizon and rose again to 0.6 inch at a depth of 4 ft. Bulk densities measured at corresponding depths were 1.4, 0.9, 1.8, and 1.9 g/cc.

The cultivated Tormentine soil has a plow layer that varies in color from yellowish red to brown depending on the amount of B horizon material turned up.

The Tormentine Series includes only the well and moderately well drained soils of the much broader Tormentine Association described in the earlier report (36). It occupies less than 20% of the area of its imperfectly drained counterpart, the Debert Series.

Use

The Tormentine soils are among the most important agricultural soils in the County because they have relatively few inherent limitations and are easy to work. Under cultivation they look and behave like soils with a higher clay content, but the clay content is frequently as low as 5%.

The use of these soils has suffered somewhat from their natural division into small units by the rolling topography and interspersed areas of poor drainage. This problem is aggravated by outdated field boundaries, lot sizes, and patterns. The coastal areas on which the soils occur are adversely affected by cold northeast winds blowing off the cold waters of the Northumberland Strait in the spring. The distance to markets has been a chronic problem for farmers.

The soils are suited to many crops, but heavy liming is needed to counter the acidity, which is severe in the rooting zone. Heavy fertilization is also essential. The soils require a minimum of drainage and some of the freely drained soils in the series are afflicted by drought in dry years.

Oats, barley, and hay are the chief crops in a farming system that is concerned mainly with the sale of milk, beef, and livestock. The acreage under corn and small grains is increasing. These soils are also well suited for growing potatoes, vegetables, and small fruits, but only limited amounts are grown. The Tormentine soils are not being used to their full potential.

Westbrook Series (97,127 acres)

A belt of Westbrook soils 2 to 3 miles wide extends across the County from near Cape Chignecto to the Colchester County line, with gaps between Southampton and Westchester. In the east the topography is undulating to gently rolling, whereas the western section includes strongly rolling to dissected terrain on the north face of the Cobequid Mountains. Carboniferous conglomerates are the main constituents of the reddish brown glacial till parent material, which is both gravelly and stony. The soils are well-drained acid sandy loams or gravelly sandy loams of little agricultural importance and mostly under forest.

A leached horizon of sandy loam 3 to 6 inches thick underlies the layer of mor or moder humus. It is pale in color, but compared with other soils retains more reddish coloring, probably due to the presence of resistant forms of Fe. Fe, Al, and

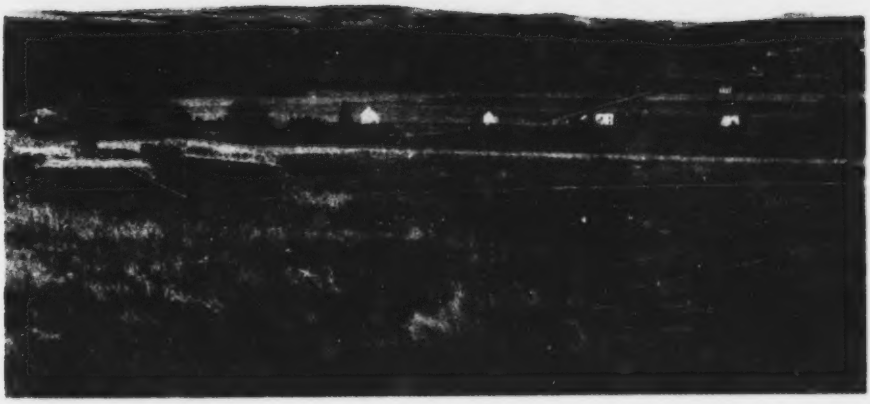

Fig. 16. Rolling areas of Westbrook soils with Cumberland soils on the valley floor, West Brook village.

organic matter have accumulated in sufficient quantities to produce a well-developed, porous, open-structured B horizon up to 15 inches thick, but its color differs only slightly from that of the reddish brown parent material. The parent material may contain small amounts of sandstone and crystalline rocks in addition to the conglomerate. Although it is frequently quite compacted, the many coarse fragments help to maintain free internal drainage.

A tendency to form incipient mull on the surface was observed in many profiles. Although the sandy loam textures are predominant, gravelly loams are found in many profiles at all levels. The typical reddish brown color of the parent material gives way to darker colors in a few areas notably between Claremont and River Philip. Areas of associated imperfectly and poorly drained soils can be found in small depressions, but they are too small to warrant separate recognition.

Use

There are only a few small areas of farmland on Westbrook soils, such as in the Westchester area. Oats, barley, and hay mixtures are the main crops. Abandoned farms are a common sight along many of the roads that traverse the area. Some of the old farm fields are used for the production of blueberries. The rest of the Westbrook soils are covered by a forest of red spruce, fir, maples, and birches. The soils permit fairly deep rooting and appear capable of sustaining quite good forest growth, but in the eastern district extensive lumbering has left large areas under poor second growth.

Surface stoniness prevents normal farming on over 75% of the Westbrook soils and on most of the remainder it would be a serious hindrance. Rough topography is an additional limitation on large tracts in the central and western parts of the County. Where the limitations of stoniness and topography are not too severe, these soils are suitable for a wide variety of crops. The need for lime and fertilizer is as great as on most other soils in the County.

Wyvern Series (53,203 acres)

Wyvern soils are distributed in a belt along the northern edge of the Cobequid Mountains from the county line in the east to the Parrsboro Gap and occupy 5% of the land area. The landscape is a complex of rolling plateau surface and steep plateau edge deeply dissected by valleys emerging to the lowlands. The soils are well drained and acid and have a coarse-textured, stony character received from their parent material, a thin mantle of brown granite-rich glacial till. Rather cool and moist upland climatic conditions are chiefly responsible for a release of organic compounds and greater than average accumulation in the B horizon. Pure hardwood stands and mixed woods dominate the forest cover; conifers are well established in the deep valleys and on old cutover land.

The organic surface mat on Wyvern soils is generally well decomposed and has a prominent H layer. In a few areas, biological intermixing of the organic matter with the underlying mineral soils has produced a dark brown Ah horizon about 3 inches thick. The upper mineral horizon (Ae) consists of 2 to 5 inches of light reddish brown leached sandy loam on a 3 to 8 inch layer of highly porous, friable, reddish brown sandy loam. Analysis of the latter discloses at least 10% organic matter in association with considerable free Fe and Al. The lower B horizon contains less organic matter and is more compact, but it contains more gravel and stones and generally permits deep penetration of plant roots. It is reddish brown to strong brown in color. A compact fragipan-like horizon may be present, but it does not seriously affect the movement of water in the soils. There may also be some cementation in the lower B horizon.

The upper boundary of the brown or reddish brown C horizon is 18 to 24 inches below the surface. The C horizon is usually a gravelly sandy loam that is very stony and may possess a variety of crystalline igneous rocks and sandstones in addition to the dominant granite. The whole profile is strongly acid.

The only notable variations among Wyvern soils involve their colors and the lithology of the parent material. For instance, the color of the upper B horizon may be lighter or darker than described due to the organic matter content ranging from around 10% on marginal sites at low elevations to 20% or more. There are large areas where rocks other than granite are responsible for medium brown or olive brown colors in the soil. These variants are usually transitional forms to the Rodney or Cobequid series respectively.

Use

Like the Cobequid soils, which they resemble in many characteristics, the Wyvern soils are primarily forest soils on account of the rugged topography and excessive stoniness. They possess the same advantage of a mellow porous B horizon and capacity for deep rooting, and the disadvantage of climatic exposure.

Significant areas of Wyvern soils on the edge of the hills from Wyvern to Wentworth were accessible to early settlers, who cleared the land and removed large

amounts of stone. Some of this land has reverted to forest, but the remainder has become one of the more important lowbush blueberry producing areas in the province. Many of the blueberry fields are being actively extended by clearing. Although the bulk of the Wyvern soils have been mapped as excessively stony for normal agricultural use, there are 4,000 acres classed as only moderately stony.

Organic Soils (14,786 acres)

Organic or peat soils are scattered throughout the County on bogs formed in old lake basins and other very poorly drained basins. The largest single area is in the Chignecto Isthmus. Permanent saturation has resulted in the accumulation of poorly decomposed remains of water-tolerant plants, which are classified as peat when the thickness exceeds 16 inches or 24 inches in the case of sphagnum moss. In upland areas the peat is derived chiefly from sphagnum mosses and is generally fibrous; the bogs are usually slightly domed. In valley bottoms in the lowland, the peat may have been derived from a wider variety of plant species, including sedges, and tends to be more decomposed and amorphous.

In the vegetation of the peat bogs, sphagnum mosses are prominent and with them are hypnum mosses, Labrador tea, sheep-laurel, rhodora, cranberry, bayberry, cotton grass, huckleberry, and witherod. Sedges and rushes are common, and in some of the lowland bogs they are dominant. Many of the bogs are treeless, but some have been invaded by stunted black spruce and tamarack.

Much of the peat is quite shallow and rests on mineral soil at depths of 4 ft or less. In both upland and lowland locations, sections through the peat frequently disclose layers in differing stages of decomposition and humification, as reflected in the breakdown of the fibers. Upland peats contain a high proportion of fibric materials (greater than 40% rubbed fiber content) and are classified as Sphagno-Fibrisols, Terric Fibrisols, and Mesic Fibrisols. Lowland peats contain more mesic and humic material and occasionally some intermixed mineral material. They include Typic, Fibric, Humic, and Terric Mesisols.

All the peat soils are extremely acid and deficient in plant nutrients. The fibric sphagnum peats have bulk densities less than 0.1 g/cc, and water-holding capacities of 15 to 30 times their own weight. The more humified peats have bulk densities of 0.1 to 0.4 g/cc and water-holding capacities as low as five times their own weight.

Peat soils containing mineral material grade into Chaswood soils in many areas. They cease to be designated as peat when the thickness of the organic material on the surface is less than 16 inches or 24 inches in the case of fibric sphagnum moss, and when the organic content falls below 30%.

Use

None of the peat bodies in the County are used for agriculture or as sources of horticultural peatmoss. A large area in the Chignecto Isthmus is maintained as a wildfowl sanctuary with a regulated water level.

Miscellaneous Land Types

Salt Marsh (5,146 acres)

Salt marshes containing fine-textured reddish brown deposits of silty clay loam are distributed around the coastline, chiefly in the mouths of creeks and rivers. Many lie outside the dykes that were built to reclaim such areas for agriculture, and inside a few that have now fallen into such disrepair as to allow sea water to enter. The salt marshes continually receive fresh sediments, but are partly stabilized by salt-tolerant plants such as sand spurrey, glasswort, and sea-rocket. The deposits are mostly alkaline in reaction, but compacted peat and dense old sediments rich in organic matter are extremely acid where sea water has been unable to penetrate. The peat bodies and acid sediments were laid down during periods of lower sea level.

Salt marshes are of little agricultural value, but some drier areas are grazed occasionally and have been cut for bedding material.

Rocky Land (9,020 acres)

The only area in the County mapped as rocky land lies south of Joggins and extends from Shulie to River Hebert. The topography is gently rolling, but the surface is very rough and ridged because of the outcropping of inclined hard sandstone beds. The soils between the rock ridges are shallow and very shallow Shulie and Economy soils. Rock outcrops and very shallow soils form 60% or more of the surface. The vegetation is a scrubby open growth of spruces, birches, and tamarack; stands are better where there is sufficient soil for rooting. Heath and erica cover open areas. Little use can be envisaged for this rugged, remote land.

Coastal Beach (311 acres)

A few areas of coastal beach have been mapped near Malagash, Parrsboro, Advocate, and Apple River. They are gravel and sand spits formed mainly during storms by the action of waves and longshore drift. The two spits enclosing Advocate Harbour are particularly good examples and have a total length of almost 4 miles.

Salt-tolerant vegetation has thinly colonized a few small areas, but the other areas are devoid of vegetation and useful only for recreation purposes.

LAND USE

Present Land Use

The chief agricultural soils of the County belong to the Acadia, Cumberland, Debert, Hansford, Pugwash, Queens, and Tormentine series. The Debert and Acadia soils have the most untapped potential for general crops. They require adequate artificial drainage and although the problem is worse on the Acadia soils, they have relatively high fertility. There are a few uncleared areas of Tormentine and Pugwash soils suitable for agriculture and much of the existing farmland is capable of higher productivity. There is fairly good potential for lowbush blueberries on many soils such as the Wyvern and Kirkhill ones, which are too stony or shallow for other types of farming. Some of the management problems on individual soils were discussed in the section "Description of the Soils," and further information appears under "Soil Capability for Agriculture."

The soils in Cumberland County support a variety of farming enterprises and the relative importance of each can be judged from the sources of farm income (Table 5). At the 1966 census, dairy products and small fruits (chiefly strawberries

Table 5. Sources of gross farm revenue, 1951 and 1966 (census data)

	1951		1966	
	$1,000	%	$1,000	%
Grains	36	1.4	19	0.5
Hay and forage crops	81	3.1	66	1.9
Potatoes, roots, and other field crops	56	2.2	37	1.1
Vegetables	27	1.0	15	0.4
Tree fruits and small fruits	41	1.6	649	18.4
Greenhouse and nursery products	-	-	373	9.7
Cattle	538	20.7	624	17.8
Pigs	278	10.7	541	15.3
Horses, sheep, and wool	32	1.2	27	0.8
Poultry and eggs	218	8.4	382	10.9
Dairy products	837	32.2	647	18.4
Other agricultural products	61	2.3	47	1.4
Forest products	392	15.2	118	3.4
Totals	2,597	100.0	3,545	100.0

Table 6. Numbers of farms in gross income classes (census data)

	1966	1961
Farm with value of products sold of:		
$25,000 and over	17	5
$15,000 – $24,999	14	9
$10,000 – $14,999	33	20
$ 5,000 – $ 9,999	22	73
$ 3,750 – $ 4,999	60	46
$ 2,500 – $ 3,749	49	108
$ 1,200 – $ 2,499	101	248
Number of commercial farms	296	509

and blueberries) were of equal importance and closely followed by cattle and pigs; these four accounted for 70% of gross farm revenue. Sales of eggs and greenhouse products each accounted for about 10%.

The earlier mixed farming system in small units, with a heavy dependence on cattle, has given way to more specialized operations in the hands of relatively few commercial farmers. There has been a marked decline in dairying and the sale of forest products in the last 15 years, accompanied by a rapid rise in the production of blueberries, strawberries, greenhouse products, and pigs. Small fruit production has been stimulated by the establishment of new freezing plants at Oxford and Parrsboro. The continuous decline in potato production is curious in view of the suitability of several of the agricultural soils for this crop.

From 1951 to 1966, the total number of farms dropped from 2,060 to 958, of which 296 were classified as commercial on the basis of gross annual sales exceeding $1,200. In 1966, 64 farms had sales worth more than $10,000, and on 17 farms they exceeded $25,000 (Table 6).

Table 7. Farm population, area and use of farmland in Cumberland County, 1951 and 1966 (census data)

	1951	1966
Population on farms	9,097	4,049
Area of all land on farms in acres	330,355	222,325
Improved land	94,655	66,509
Under crops	63,513	43,188
Summerfallow	309	192
Pasture	27,740	20,137
Other	3,093	2,992
Unimproved land	235,700	155,816
Woodland	187,395	127,860
Other	48,305	27,956

Table 8. Acreages of field crops in Cumberland County and percentages of provincial totals, 1951 and 1966 (census data)

	1951		1966	
	Cumb. Co.	% of N.S.	Cumb. Co.	% of N.S.
Hay	45,386	13.2	29,028	12.9
Oats	10,965	17.8	4,466	17.4
Mixed grains	3,295	37.5	3,201	31.7
Wheat	347	27.8	136	9.8
Barley	863	19.5	492	13.7
Buckwheat	368	56.7	51	31.2
Rye	5	0.7	25	1.5
Field beans	27	8.9		
Corn for grain	3	15.8	1	1.3
Field peas	2	2.3		
Fodder crops	18	2.5	147	4.4
Potatoes	877	7.7	314	5.0
Turnips, swedes, and mangels	615	14.2	151	11.3
Vegetables	95	3.3	70	1.9
Tree fruits	153	0.7	15	0.1
Small fruits	225	16.8	4,811	47.3
All field crops	62,962	14.0	43,164	13.8
Greenhouses (ft^2)	36,240	7.5	201,140	17.4

In 1966, farms occupied 222,325 acres, or 21% of the County, of which 155,816 acres were wooded or otherwise unimproved and 66,509 acres were improved (Table 7). This compared with 113,814 acres of improved land in 1931. The area under crops decreased from 76,267 to 43,164 acres in the same period; large areas of Debert and Queens soils reverted to pasture or woodland. In the last 3 or 4 years acreages of barley, spring wheat, winter wheat, and fall rye have been increasing. These are grown for feed grain, but some oats and barley are grown for seed (14). Oats remain popular due to their ability to yield moderately on poorly managed acid soils of low fertility. The acreage planted to corn for silage has expanded rapidly in a few localities in recent years. Serious soil erosion losses can be predicted for the sloping fields under this crop, unless more attention is given to conservation practices.

The acreages under different crops and changes between 1951 and 1966 are given in Table 8.

Table 9. Yields of various crops on the main agricultural soils

	Tormentine, Pugwash	Debert	Cumberland	Acadia[d]	Queens	Masstown
Oats, bu/acre	65 (90)	55 (90)	70 (90)	55 (90)	45 (80)	25 (40)
Barley, bu/acre	55 (85)	45 (80)	60 (90)	50 (75)	40 (70)	
Wheat, bu/acre	50 (75)	40 (75)	55 (75)	40 (70)	30 (60)	
Hay, tons/acre	2.5 (4)	2 (4)	3 (4)	2.5 (4)	2.5 (4)	2 (3)
Alfalfa, tons/acre	3.5 (5)	2.5	4 (5)	3.5 (5)		
Corn silage, tons/acre[b]	15 (25)	12 (25)			10 (20)	
Grass silage, tons/acre[c]	10 (15)	10 (15)		10 (15)	10 (15)	6 (10)
Tomatoes, lb			20,000			
Strawberries, quarts			8,000 (12,000)			

[d]Imperfectly drained
[b]25–28% dry matter (D.M.)
[c]30% D.M.
Note: Figures in parentheses are the high yields obtainable in good years.

Table 10. Numbers of livestock in Cumberland County and percentage of provincial total (census data)

	1951		1966	
	Cumb. Co.	% of N.S.	Cumb. Co.	% of N.S.
Cows and heifers for milk production	10,235	10.0	4,622	7.8
Steers (1 year and over)	808	7.2	1,696	10.4
Pigs	5,513	11.4	6,604	11.5
Sheep	2,522	2.6	2,336	6.0
Horses and ponies	3,077	11.8	583	10.2
Hens and chickens	117,532	7.2	81,449	2.9
Turkeys	1,356	4.4	359	0.9
Ducks and geese	1,590	17.3	578	24.3

It is difficult to predict differences in crop yields between soils in Cumberland County, because all except the Acadia soils demand very high applications of fertilizers and lime for most crops. Crop yields are related more to the success of management, and for problem soils this means the ability to overcome physical limitations such as dense subsoil, excess water, surface stone, and erosion, while supplying the necessary fertility. In the prevailing climate, the best crop grown with optimum inputs on the best soils may be impossible to harvest in some years. The average yields of various crops for the chief agricultural soils, given in Table 9, are therefore rough approximations. The averages are those expected over a number of good and bad years assuming good management by commercial farmers and allowing for their occasional inability to complete the harvest. The soils listed do not include the stony or strongly sloping phases of the series.

Parallel with the shrinking arable acreage between 1931 and 1966 the numbers of cattle on farms decreased, but the number of pigs increased (Table 10). Poultry declined numerically, but, like other livestock, has been concentrated in fewer more efficient units.

Forests, including farm woodlots, cover 81% of the County and are composed

of 46% softwoods, 31% mixed woods, and 23% hardwoods (Table 11). The composition of the forests by species was discussed in the section "Vegetation." The average annual production of sawn products in the period 1964 to 1968 was 4.6 million ft^3 of softwood and 345,000 ft^3 of hardwood. The production of round products averages 1.9 million ft^3 of softwood and 41,000 ft^3 of hardwood (28).

Table 11. Acreages of forest types

Forest land classification	Crown land	Large owner	Small owner	Total	% of total
Softwood land	70,270	134,100	191,640	396,010	46
Mixed-wood land	25,390	78,430	157,610	261,430	31
Hardwood land	27,740	68,580	96,580	192,910	23
Total forest land	123,400	281,110	445,830	850,370	100

Data provided by Nova Scotia Forest Inventory, Truro Subdivision, N.S. Department of Lands and Forests, 1968.

Soil Capability Classification for Agriculture and Development Problems

The soil capability classification for agricultural purposes is an interpretive grouping of soils made from soil survey data. It is a nationwide system developed for the Canada Land Inventory (10). The mineral soils are grouped into seven classes according to their potentialities and limitations for agricultural use. The first three classes are considered capable of sustained production of common cultivated crops, and the fourth is marginal for sustained arable culture. The fifth is capable of use only for permanent pasture and hay, the sixth is capable of use only for wild pasture, and the seventh class is for soils and land types considered incapable of use for arable culture or permanent pasture. For the purpose of this classification, trees, tree fruits, cranberries, blueberries, and ornamental plants that require little or no cultivation are not considered as cultivated or common field crops.

The class is a grouping of subclasses that have the same relative degree of limitation or hazard. The subclass denotes the kind of limitation or hazard. Twelve kinds of limitation are recognized: adverse climate (C); poor soil structure or low permeability or both (D); erosion (E); low fertility (F); inundation (I); moisture deficiencies attributable to soil characteristics (M); salinity (N); stoniness (P);

shallowness to bedrock (R); a combination of adverse soil characteristics (X); adverse topography, slope, or pattern (T); and excess water other than that due to inundation (W). In addition in the present survey the D subclass was subdivided, by using the symbol d to identify some soils in which the poor structure, in this case a fragipan, and low permeability are believed to be more easily ameliorated.

The capability classification is applied to undisturbed as well as cultivated soils and is based on the following assumptions: (i) the soils will be well managed under a largely mechanized system; (ii) soils that can be improved by practical means are classified according to their limitations in use remaining after improvements have been made; (iii) capability groupings may be changed as new information about soils becomes available or when major reclamation works permanently change the limitations in use for agriculture; (iv) distance to market, kind of roads, location, size of farms, characteristics of landownership and cultural patterns, and the skill and resources of individual operators are not criteria for capability groupings.

The capability classifications of all the soils mapped are given in the tables accompanying the following discussion (Tables 12 to 17) and therefore a separate soil capability map has not been prepared. The tables list all the soil phases, their acreages, and the capability classes and subclasses into which they fall. The phase symbols express the conditions of topography and stoniness within a given soil series. The symbols for topography are:

Symbol	*Slope %*		*Topography*
A	0	0.5	nearly level
B	0.5+	2	gently undulating
C	2+	5	undulating
D	5+	9	gently rolling
E	9+	15	moderately rolling
F	15+	30	strongly rolling
G	Over 30		very steeply rolling

The symbols for stoniness are:

Symbol	*Degree of Stoniness*
0	Free from stones
1	Slightly stony, no hindrance to cultivation
2	Moderately stony, enough stones to interfere with cultivation unless removed
3	Very stony, enough stones to be a serious handicap to cultivation

The full physical potential of agriculturally suitable soils is more likely to be realized if they occur in significant contiguous areas with a high proportion of land already cleared and suited to crops other than forage and having good access to markets. These and other cultural and economic factors were superimposed on the land base of the province by Hilchey using a system of land blocking (18). Fifteen multicrop blocks covering 930,000 acres were delineated in Nova Scotia. Viable farming operations will be centered on these blocks with some use being made of the land in a further 54 limited-use blocks. Five of the multicrop blocks, covering 153,000 acres, are located in northern Cumberland County and 39% of the land is presently cleared. The soils are chiefly Pugwash, Tormentine, Debert, and Queens and 90% belong to capability classes 2 and 3.

Soil Capability Class 1

Soils in this class have no important limitations in use for crops. They are level or have very gentle slopes; they are deep, well to imperfectly drained and have a good water-holding capacity. They are easily maintained in good tilth and productivity, and damage from erosion is slight. They are moderately high to high in productivity for a wide range of field crops adapted to the region.

There are no soils in Cumberland County that meet all these requirements.

Soil Capability Class 2

Soils in this class (Table 12) have moderate limitations that restrict the range of crops or require moderate conservation practices. They are deep and have a good water-holding capacity. The limitations are moderate and soils can be managed and cropped with little difficulty. The soils are moderately high to high in productivity for a fairly wide range of field crops adapted to the region.

The limitation of soils in this class may be any one of the following: adverse regional climate; moderate effects of cumulative undesirable characteristics; moderate effects of erosion; poor soil structure or slow permeability; low fertility that can be corrected with consistent moderate applications of fertilizers and usually lime; gentle to moderate slopes; occasional damaging inundation; and wetness that can be reduced by drainage but continues as a moderate limitation.

In Cumberland County the Hansford, Pugwash, and Tormentine soils of this class occupy 32,944 acres or 3.2% of the land area. These soils have slopes less than 5% and not enough stone to interfere with cultivation. The maintenance of organic matter, pH, and fertility are the main management problems.

The area of soils in Class 2 is much less than indicated on the 1:250,000 soil capability maps of the Canada Land Inventory (9). These maps were based on the previous soil survey of the County (36), which was less detailed than the present map, and some of the soils were rated too highly. Many of the soils remaining in Class 2 may still be overrated, because their lack of fertility or low cation-exchange capacity may be sufficient grounds to put them in Class 3. Furthermore, they demand erosion control measures under certain crops such as corn.

Soil Capability Class 3

Soils in this class (Table 13) have moderately severe limitations that restrict the range of crops or require special conservation practices. The soils have more severe limitations than those in Class 2 and conservation practices are more difficult to apply and maintain. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops adapted to the region.

In this class the limitations that restrict cultivation, ease of tillage, planting and harvesting, the choice of crops, and the application and maintenance of conservation practices are a combination of two of those described under Class 2 or one of the following: moderate climatic limitations including frost pockets; moderately severe effects of erosion; intractable soil mass or very slow permeability; low fertility that can be corrected with consistent heavy applications of fertilizers and usually lime; moderate to strong slopes; frequent inundation accompanied by crop damage; poor drainage resulting in crop failures in some years; low water-holding capacity or slowness in release of water to plants; stoniness sufficiently severe to be a serious handicap to cultivation and requiring some clearing; restricted rooting zone; moderate salinity.

Table 12. Soils in Capability Class 2, moderate limitations

Texture	Soil series	Soil phase	Capability classification	Acres
Moderately coarse	Hansford	C - 1	2FC	1,192
	Tormentine	B - 1	2FC	725
		C - 0	2FC	9,804
		C - 1	2FC	5,795
Moderately coarse to medium	Pugwash	B - 1	2FC	116
		C - 0	2FC	721
		C - 1	2FC	14,591
		Total area (Class 2)		32,944

Table 13. Soils in Capability Class 3, moderately severe limitations

Texture	Soil series or complex	Soil phase	Capability classification	Acres
Moderately coarse	Bridgeville	A - 0	3IW	132
		B - 0	3IW	191
		B - 2	3IW	179
		C - 0	3IW	116
		C - 2	3IW	240
	Debert	B - 0	3d	574
		B - 1	3d	15,584
		B - 2	3d	741
		C - 0	3d	15,910
		C - 1	3d	46,910
		C - 2	3d	35,392
		C/D - 2	3d	9,952
	Hansford	C - 2	3P	3,567
		D - 2	3T	3,069
	Kirkhill	C - 1	3R	124
	Shulie	C - 2	3P	1,188
	Springhill	C - 2	3d	1,109
	Tormentine	B - 2	3P	387
		C - 2	3P	403
		D - 0	3T	6,640
		D - 1	3T	2,209
	Westbrook	C - 2	3P	2,396
		D - 1	3T	1,032
		D - 2	3T	16,535
Moderately coarse to medium	Cumberland	A - 0	3I	414
		B - 0	3I	2,877
		B - 1	3I	2,351
		C - 0	3I	1,056
		C - 1	3I	1,332
		C - 2	3I	108
	Pugwash	B - 2	3P	379
		C - 2	3P	8,002
		D - 0	3T	219
		D - 1	3T	6,843
		D - 2	3T	4,013
	Rodney	D - 1	3T	630
		D - 2	3T	2,259
Moderately fine	Acadia complex (Ac)	A - 0	3DW	7,858
	Falmouth	C - 1	3D	1,212
		C - 2	3D	1,255
		D - 1	3D	2,308
		Total area (Class 3)		207,696

The soils in this class occupy 20% of the land area of the County or 207,696 acres. These, together with the soils in Class 2, are the resource upon which general agriculture will develop in the County in future years. They have slopes of less than 9%, but stoniness is sufficent to interfere with cultivation on 44% of Class 3 soils.

Imperfect drainage is a problem on 65% of the soils and it is almost entirely due to poor structure and low permeability of the subsoil. Effective methods of underdrainage must be sought and where tiles and plastic tubes prove uneconomical, deep tillage practices may be the only method of lowering the perched water table and raising the vertical and lateral hydraulic conductivity to a satisfactory level.

Slopes, wet spots, and small field size may be significant handicaps. Slopes assist soil drainage, but when they exceed 7% they hamper the operation of much modern farm machinery. Erosion occurs on gentler slopes than these and is a serious problem on corn fields and other areas where the soil surface remains unprotected from raindrop impact for long periods. Soil losses from erosion are high on most sloping arable land in Cumberland County because the inherently weak structure and coherence of the surface soil cannot withstand the pounding of raindrops and because of the high proportion of surface runoff on dense soils. Although major gullying is uncommon, an acre of cultivated sloping land loses many tons of soil each year by the insidious mechanism of downhill raindrop splash and sheet erosion. These losses can be curbed by raising the level of soil organic matter and by adequate surface protection. Cross-slope cultivation is helpful but can interfere with drainage.

Frequently it is worthwhile to drain wet spots to enlarge the fields even though the soils (usually Masstown or Kingsville) are unattractive. Some of the soils listed in Table 13, including Bridgeville, Kirkhill, Shulie, Springhill, Westbrook, and Rodney, occur in isolated locations or small pockets remote from thriving agricultural areas, and full use of some of these may not be practical. Some specific problems encountered in farming each soil were discussed under "Description of the Soils."

Soil Capability Class 4

Soils in this class (Table 14) have severe limitations that restrict the range of crops or require special conservation practices or both. They are suitable for only a few crops, or the yield for a range of crops is low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting, harvesting, and the application and maintenace of conservation practices. These soils are low to medium in productivity for a narrow range of crops, but may have higher productivity for a specially adapted crop.

The limitations include the adverse effects of a combination of two or more of those in Classes 2 and 3 or one of the following: moderately severe climate; very low water-holding capacity; low fertility that is difficult or not feasible to correct; strong slopes; severe past erosion; very intractable mass of soil or extremely slow permeability; frequent inundation with severe effects on crops; severe salinity causing some crop failures; extreme stoniness requiring considerable clearing to permit annual cultivation; very restricted rooting zone, but more than 1 ft of soil over bedrock or an impermeable layer.

These soils occupy 202,226 acres or 19.4% of the land area of the County. They are marginal for arable crops for a variety of reasons, which were discussed earlier under the individual soil series. Debert soils on which slope is added to their other

Fig. 17. Class 4 land on Queens and Westbrook soils reverting to alder scrub, Springhill.

limitations have been downgraded to this class. Queens soils could not be rated higher that Class 4 because of the difficulty of combatting the imperfect drainage caused by a dense subsoil. Slopes are as steep as 15%, and stoniness is sufficient to interfere with cultivation on 32% of Class 4 soils. Poor subsoil structure and associated low permeability is a problem on 80% of them, so that 40% are poorly drained and another 40% are imperfectly drained.

Soil Capability Class 5

Soils in this class (Table 15) are capable of producing only perennial forage crops, but improvement practices are feasible. Because of serious soil, climatic, or other limitations these soils are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing, and water control.

The limitations include the adverse effects of one or more of the following: severe climate; low water-holding capacity; severe past erosion; steep slopes; very poor drainage; very frequent inundation; severe salinity permitting only salt-tolerant forage crops to grow; and stoniness or shallowness to bedrock that makes annual cultivation impractical.

In Cumberland County, soils in Class 5 are limited by flooding, wetness, steep slopes, shallowness, and droughtiness. They cover 3.2% of the land area.

Table 14. Soils in Capability Class 4, severe limitations

Texture	Soil series or complex	Soil phase	Capability classification	Acres
Very coarse to moderately coarse	Hebert	B 0	4M	207
		B 1	4M	4,396
		B 2	4M	179
		B/C 1	4M	343
		C 0	4M	1,794
		C 1	4M	6,440
		C 2	4M	3,585
		D 1	4M	6,401
		D 2	4M	884
Moderately coarse	Debert	D 0	4dT	881
		D 1	4dT	1,132
		D 2	4dT	2,363
	Economy	B 2	4Wd	311
	Kirkhill	C 2	4RP	279
		D 1	4TR	4,950
		D 2	4TR	2,913
	Masstown	B 0	4Wd	34,077
		B 1	4Wd	10,518
		B 2	4Wd	949
		B/C 0	4Wd	1,451
		C 0	4Wd	1,782
		C 1	4Wd	5,699
		C 2	4Wd	6,190
	Rossway	D 2	4TR	207
	Shulie	D 1	4TR	124
		D 2	4TR	311
	Tormentine	E 0	4T	295
		E 1	4T	327
	Westbrook	E 1	4T	236
		E 2	4T	893
	Wyvern	D 1	4TR	240
		D 2	4TR	2,072
Moderately coarse to medium	Pugwash	E 2	4T	128
	Rodney	E 1	4T	326
		E 2	4T	2,790
Moderately fine	Acadia complex (Ac-b)	A 0	4DW	4,601
	Kingsville	C 0	4DW	116
		C 1	4DW	4,328
		C 2	4DW	1,626
	Queens	B 1	4D	1,949
		B 2	4D	1,319
		C 0	4D	530
		C 1	4D	36,141
		C 2	4D	21,634
		C/D 0	4D	379
		D 0	4D	311
		D 1	4D	6,680
		D 2	4D	4,312

Table 14. Soils in Capability Class 4, severe limitations (cont'd)

Texture	Soil series or complex	Soil phase	Capability classification	Acres
Moderately fine to fine	Diligence	C 1	4D	558
		C 2	4D	571
		D 1	4D	195
		D 2	4D	2,244
	Joggins	C 2	4DW	7,879
		D 2	4DW	1,180
		Total area (Class 4)		202,226

Table 15. Soils in Capability Class 5, limited to producing perennial forage crops

Texture	Soil series	Soil phase	Capability classification	Acres
Very coarse to moderately coarse	Hebert	E 1	5MT	916
		E 2	5MP	1,686
	Millar	B 0	5W	487
		B 1	5W	1,041
		C 1	5W	326
		C 2	5W	104
Moderately coarse	Cobequid	D 2	5RT	207
	Kirkhill	E 1	5TR	112
		E 2	5TR	13,387
	Masstown	A 0	5Wd	120
	Tormentine	F 0	5T	143
	Wyvern	D/E 2	5TR	1,586
		E 2	5TR	104
Medium to moderately fine	Chaswood	A 0	5IW	247
		B 0	5IW	4,083
		B 1	5IW	1,351
		B 2	5IW	187
		C 1	5IW	776
		C 2	5IW	231
Moderately fine	Kingsville	B 1	5DW	2,252
		B 2	5DW	1,096
	Queens	E 2	5TD	211
		F 2	5TD	92
Moderately fine to fine	Diligence	E 2	5TD	1,383
	Joggins	B 1	5DW	805
		C 1	5DW	534
		Total area (Class 5)		33,467

Soil Capability Class 6

Soils in this class (Table 16) are capable of producing only perennial forage crops, and improvement practices are not feasible. They have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic, or other limitations as to make impractical the application of improvement practices that can be carried out in Class 5. Soils may be placed in this class because their physical nature prevents improvement through the use of farm machinery, or the soils are not responsive to improvement practices, or because of a short grazing season, or because stock-watering facilities are inadequate. Such improvement as may be effected by seeding or fertilizing by hand or by aerial methods shall not change the classification of these soils.

The limitations include the adverse effects of one or more of the following: very severe climate; very low water-holding capacity; very steep slopes; very severely eroded land with gullies too numerous and too deep for working with machinery; severely saline land producing only edible, salt-tolerant, native plants; very frequent inundation allowing less than 10 weeks effective grazing; water on the surface of the soil for most of the year; stoniness or shallowness to bedrock that makes any cultivation impractical.

Where costly clearing is required to change soils of Class 7 to Class 6, the areas are rated as Class 7. In Cumberland County, Salt Marsh, the wettest areas of the dykeland, and some shallow Kirkhill soils on very rugged topography have been placed in this class. They comprise only 1.9% of the land area.

Soil Capability Class 7

Soils in this class (Table 17) have no capability for arable culture or permanent pasture. All classified soils (except organic soils) not included in Classes 1 to 6 are placed in this class.

Class 7 soils may or may not have a high capability for trees, native fruits, wildlife, and recreation. No inference is made as to the capability of the soils and land types in this class beyond the scope of their capability for agriculture.

In Cumberland County the land in this class occupies 51% of the land area. The main limitations are extreme stoniness or steep slopes. Almost all this land is under forest.

Organic Soils

Organic soils are not rated in the soil capability classification. None of the peat areas have been improved for agricultural use. Peat occupies 14,786 acres or 1.4% of the County.

Land Capability for Forestry*

In the Canada Land Inventory all mineral and organic soils in the province were classified into one of seven forest capability classes. "Associated with each capability class is a productivity range based on the mean annual increment of the best species or group of species adapted to the site at or near rotation age. Productivity ranges are expressed in gross merchantable cubic foot volume down to a minimum diameter of four inches. The productivity ranges are for "normal" or fully stocked stands. Thinning, bark and branch wood were not included." (11)

*Prepared by R.E. Bailey and G.M. Mailman.

Table 16. Soils in Capability Class 6, limited to producing unimproved pasture

Texture	Soil series, complex, or land type	Soil phase	Capability classification	Acres
Very coarse to moderately coarse	Millar	B 3	6WP	120
Moderately coarse	Kirkhill	E/F 1	6TR	97
		E/F 2	6TR	10,891
		F 2	6TR	1,578
Moderately fine	Salt Marsh		6IN	5,146
Moderately fine to fine	Acadia complex (Ac-w)	A 0	6W	1,123
		B 0	6W	641
		Total area (Class 6)		19,596

Table 17. Soils in Capability Class 7, unsuitable for agriculture

Texture	Soil series	Soil phase	Capability classification	Acres
Very coarse	Coastal Beach		7X	311
Very coarse to moderately coarse	Hebert	B 3	7P	128
		C 3	7P	136
		D 3	7P	160
		D/E 3	7P	387
		E 3	7P	144
		F 2	7MT	151
Moderately coarse	Cobequid	B 3	7PR	179
		C 3	7PR	128
		D 3	7PR	9,597
		D/E 3	7PR	49,644
		E 3	7PR	10,036
		E/F 3	7PR	4,978
		F 3	7PR	5,995
		G 3	7PR	3,459
	Debert	B 3	7P	590
		C 3	7P	4,859
		D 3	7P	8,545
	Economy	B 3	7P	4,993
		C 3	7P	17,542
		D 3	7P	918
	Hansford	C 3	7P	5,177
		D 3	7P	6,070
	Kirkhill	D 3	7PR	4,746
		E 3	7PR	4,248
		F/G 2	7TR	1,343
		G 2	7TR	1,598
		G 3	7PR	761
	Masstown	B 3	7P	558
		C 3	7P	1,379
	Rossway	D 3	7PR	486
		E/F 3	7PR	1,522
		F 3	7PR	163

Table 17.Soils in Capability Class 7, unsuitable for agriculture (cont'd)

Texture	Soil series	Soil phase	Capability classification	Acres
	Shulie	C - 3	7PR	52,379
		D - 3	7PR	51,159
		D/E - 3	7PR	2,096
		E - 3	7PR	104
		F - 3	7PR	446
	Springhill	B - 3	7P	271
		C - 3	7P	24,571
		D - 3	7P	9,845
	Westbrook	C - 3	7P	6,114
		D - 3	7P	24,895
		D/E - 3	7P	26,416
		E - 3	7P	5,238
		E/G - 3	7P	4,776
		F - 3	7P	7,122
		G - 3	7P	1,474
	Wyvern	D - 3	7PR	22,415
		D/E - 3	7PR	12,323
		E - 3	7PR	3,499
		F - 3	7PR	8,071
		F/G - 3	7PR	2,439
		G - 3	7PR	454
	Rocky Land		7R	9,020
Moderately coarse to medium	Cumberland	C - 3	7P	136
	Pugwash	C - 3	7P	8,628
		D - 3	7P	3,875
	Rodney	C - 3	7P	17,095
		D - 3	7P	51,621
		E - 3	7P	8,521
		F - 3	7P	1,957
Moderately fine	Kingsville	C - 3	7P	805
	Queens	C - 3	7P	1,881
		D - 3	7P	155
		F - 3	7P	108
Moderately fine to fine	Diligence	D - 3	7P	5,716
		E - 3	7P	2,300
	Joggins	C - 3	7P	1,248
		Total area (Class 7)		530,104

Table 18. Distribution of land in the different capability classes

Capability class	Acres	Percentage of total land area
2	32,944	3.2
3	207,696	20.0
4	202,226	19.4
5	33,467	3.2
6	19,596	1.9
7	530,104	50.9
Peat	14,786	1.4
Total land area	1,040,819	100.0

The assignment of each unit of land to a particular class was based on all known or inferred information about the unit, including soil moisture, texture, rooting depth, fertility, climate, stoniness, and vegetation. In addition to the capability class, the map symbol also includes a capability subclass and indicator tree species. The capability subclass indicates the environmental factor or factors most limiting to potential tree growth. The indicator species designates that tree species expected to yield the volume associated with each class. The classification is based on the inherent ability of the site to produce wood fiber and does not reflect improvements in site quality that could be achieved through such action as forest fertilization and soil drainage.

No areas of capability classes 1 and 2 were mapped in Cumberland County. Class 3 land (71–90 ft^3/acre per year) was mapped infrequently and occupies only 0.5% of the land area. Class 3 land was associated with the better soils that in this context are defined as the deeper, well-drained, and in some cases telluric soils of the Hebert, Cumberland, Tormentine, Queens, Debert, and Pugwash series occurring on the protected lower slopes and valley bottoms. These sites have no limitation to forest growth other than regional climate.

Classes 4 and 5 are the most common capability classes mapped in Cumberland County. Class 4 land whose productivity is from 51 to 70 ft^3/acre per year occupies 40% of the land area and generally occurs on the moderately deep soils of the valley bottoms and hillsides. The more common soils mapped as Class 4 include the better-drained portions of the moderately fine textured Diligence and Queens soils; the moderately coarse and coarse-textured Pugwash, Rodney, Hansford, Tormentine, Debert, Wyvern, and Westbrook soils, and the water-deposited Hebert and Cumberland soils. In addition to the regional limitations of climate and fertility most of the Class 4 soils are limited by dense subsoil or compacted horizons that have the effect of restricting water and root penetration.

Class 5 land with a productivity of from 31 to 50 ft^3/acre per year occupies 50% of the land area and is generally confined to the imperfectly drained soils, the burned-over portions of the Shulie soils, and the more exposed or shallower soils, or both, of the Cobequid, Wyvern, Kirkhill, and Rodney series.

Class 6 and 7 land produces from 0 to 30 ft^3/acre per year and occupies 10% of the land area including the organic soils, swamps, salt marshes, eroded slopes, tidal flats, severely burned shallow soils, and the extremely exposed areas. Exposed bedrock, shallow soils, dense layers of ericaceous vegetation or poor drainage, or both, severely limit the capability of these areas for forestry.

Civil Engineering Aspects*

Planning of civil engineering works can be aided by foreknowledge of the conditions that will be encountered at the site of the works. Foremost among these are the soil, bedrock, and groundwater conditions. The purpose of this section is to summarize the information contained in the preceding chapters, from the viewpoint of the civil engineer. However, where a particular soil is involved, the specific section dealing with that soil should be studied as well as this section. The sections dealing with climate, physiography, and geology, and the section entitled "How the Soils were Mapped" should be studied also.

*Prepared by J. D. Brown, Department of Civil Engineering, N.S. Technical College.

In civil engineering, soil is defined as all the mineral material† above a clearly distinguishable lithified bedrock. The term will be used in this sense in the following discussion; it differs from the use of the word "soil" in other parts of this report. The surface layers (A and B horizons) are of secondary interest because they are generally unsuitable for engineering purposes and will be removed from any construction site. Engineering considerations involve what is referred to in this report as the C horizon or parent material or both. The engineering properties that are of chief importance are:

1. Strength of the soil
2. Compressibility of the soil
3. Thickness and sequence of soil strata
4. Groundwater flow pattern
5. Grain size distribution
6. Permeability

These properties are considered in the design of building foundations, in the selection of materials for earthworks, and as an important item in highway construction.

A further problem that is of importance in engineering is off-road trafficability. Because this is a property of the surficial soil layers, it is closely related to the soil series and is discussed separately at the end of this chaper.

The interests and perspective of civil engineering are different from those of farming and forestry; hence in seeking to delineate the above properties several limitations of this report must be recognized. First, the soil series are frequently based on factors of agricultural significance, and, as a result, the engineering properties can vary as much within one series as they do between different series. Second, the present mapping scale severely restricts the number of useful generalizations of some of these properties that may be made. Third and at present most important, there is inadequate detailed information on some of the engineering properties listed above. Available analytical data are presented in Appendix 2, under "Engineering Data."

The problems posed by map scale and inadequate information must be accepted as deficiencies in the report. All information bearing on engineering soil properties is, however, presented in the following pages.

The problems presented by the first limitation may be reduced by regrouping the soil series and cutting down the number of apparently distinct types. This can be done without prejudice to the pedological system of soil classification. In this new classification, the soil material forming factors determine the groupings. The factors of importance in Cumberland County are:

1. Type and extent of underlying bedrock
2. Glacial ice action
3. Glacial meltwater (rivers and lakes) action
4. Recent and present-day river and stream action
5. Tidal and wave action.

Associated with these main factors are the effects of topography, climate, vegetation, and time. These act interdependently to modify the soil deposits formed,

†Peat is also considered to be soil, although it does not contain significant mineral material.

but they are not dominant in the region, except that these are the chief factors in the formation of peat bogs.

In terms of world patterns of soils, in the engineering sense, chemical weathering and wind are important soil-forming factors, but they do not represent important agents in Cumberland County.

As a result of these considerations, the soils are grouped as:

(a) glacial tills
(b) water-laid deposits
(c) miscellaneous soils.

Glacial Tills

The soil series that are derived from glacial tills are listed in Table 19. This table shows that the 19 soil series can be reduced to eight descriptive groups. These can be further reduced to three soil types distinguished by the characteristics of the fine grain size portion or matrix, i.e., clayey, silty, or granular. The main basis for the classification are the descriptions given under "Description of the Soils." In addition, sieve analyses, Atterberg limits, and petrographic analyses have been performed on representative samples, and these have been bases for classifying the soils using the Unified Soil Classification System (35). The general properties of the soils with respect to engineering uses are given in this publication and in most textbooks on soil mechanics.

In addition to these properties, most glacial tills of Nova Scotia, due to preloading by ice, are dense or stiff soils with low water contents, high shear resistance, and low compressibility. This is certainly true of ground moraines (basal till) but may not be true to the same degree for terminal moraines, ablation till, and lateral moraines. Available information does not permit classifying the tills of Cumberland County according to these modes of formation, but they appear to be principally ground moraines. For important engineering work or where heavy structure loads are involved, detailed borings are required to establish the exact nature of the till at a given site.

Furthermore, available information on the thickness of the till deposits is insufficient to allow any conclusions to be drawn in this regard, except as noted in Table 19.

Water-laid Deposits

The soil series that are derived from water-laid deposits are listed in Table 20. This table shows that the six series can be reduced to four descriptive groups, distinquished by the mode of deposition. Soil deposits laid down by rivers and streams have extensive variations in grain size both vertically and horizontally. There are layers and lenses ranging from coarse gravels to fine sands and silts, and from a few inches to several feet in thickness, within even a small area such as a gravel pit. Most of the soil series must, therefore, be described as undifferentiated sands, silts, and gravels. The Hebert and Millar series of sands and gravels tend to be coarser than the Cumberland and Bridgeville series and tend to become less coarse, and to contain less granitic and metamorphic rock with increasing distance from the original glacial meltwater sources in the Cobequid Mountains. The Hebert sands and gravels may be expected to underly the recent alluvial series in many locations. The Hebert, Cumberland, and Bridgeville series are good sources of sand

Table 19. Engineering classification of soils derived from glacial till

Engineering description[a]	Soil series	Parent bedrock	USCS symbol[b]	Factors affecting use for foundations and earth structures	Est. permeability below 2-ft depth[d]
1. Reddish brown clayey till	Queens	Mixed Carboniferous sedimentary bedrock	CL	Periodic perched water table	Very slow
	Kingsville		Minor	High water table	Very slow
	Falmouth		ML	No limitations	Slow
2. Reddish brown to grayish brown clayey to silty till	Joggins	Mixed Carboniferous sedimentary bedrock	CL	High water table, sometimes shallow	Very slow
			Minor		
	Diligence		ML	Periodic perched water table, shallow	Very slow
3. Reddish brown silty till	Debert	Mixed Carboniferous sedimentary bedrock	SM	No limitations	Very slow
	Pugwash			No limitations	Slow
	Masstown			Perched water table	Very slow
	Tormentine			No limitations	Slow
4. Brown to reddish brown silty till	Shulie	Mixed Carboniferous sedimentary bedrock	GM to SM	Stony, shallow	Slow-medium
	Springhill			Stony, perched water table, shallow	Very slow
	Economy			Stony, high water table, shallow	Slow-medium
5. Reddish brown to grayish brown granular till	Hansford	Mixed Carboniferous sedimentary bedrock	GM to SM	No limitations	Medium
	Westbrook			Shallow in places	Medium
	Rodney			Shallow	Medium-rapid
6. Olive brown and reddish brown granular till	Cobequid	Devonian, igneous, and metamorphic bedrock	GW to GW-GM	Stones and boulders, shallow	Medium-rapid
	Wyvern			Steep slopes	Medium-rapid
7. Olive gray shaly till	Kirkhill	Carboniferous sedimentary bedrock	GP-GM	Soft shale predominant in coarse grain sizes, stony, shallow	Rapid
				Steep slopes	
8. Brown granular till	Rossway	Triassic basalt	GW-GM	Stony, shallow	Rapid

[a] For more complete descriptions see "Descriptions of the Soils."

[b] Unified Soil Classification System (USCS).
CL – Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
GW – Well-graded gravels, gravel-sand mixtures; little or no fines.
GP – Poorly graded gravels or gravel-sand mixtures; little or no fines.
GM – Silty gravels, gravel-sand-silt mixtures.
ML – Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.
SM – Silty sand; sand-silt mixtures.
SC – Clayey sands; sand-clay mixtures.

[c] The factors listed are in addition to those understood from the USCS; they vary somewhat for the different slope and stoniness phases as mapped.

[d] Estimates were based upon relatively few laboratory determinations and observations of soil morphology in the field. Very slow is less than 0.2 inch/hr when saturated; slow 0.2-0.6, medium 0.6-2, rapid 2-6, and very rapid more than 6.

Note: Within each of the three groups of soil series, Queens, Kingsville, and Falmouth; Debert, Pugwash, Masstown, and Tormentine; and Shulie, Springhill, and Economy; the individual series are differentiated mainly on the basis of drainage but are otherwise identical from an engineering standpoint. Engineering properties of groups 1 and 2 are believed to be broadly similar, also those of groups 3 and 4. Groups 5 to 8 inclusive are differentiated mainly on the basis of significantly different origin and type of rocks in coarse particle sizes.

and gravel for construction purposes and are discussed more fully in the next section.

The Chaswood Series, although closely related to Cumberland and Bridgeville soils, tends to consist of fine-grained soils and may be partly lacustrine in origin. The history of the Chaswood soils indicates that they are normally consolidated soft or loose deposits of medium to high compressibility.

The Acadia Series is in a special category because of its marine origin and the dyking and drainage carried out. Engineering data are limited and these fine-grained soils, in places containing somewhat organic layers, should be assumed to be normally consolidated and to possess high water contents, high compressibility, and low shear resistance. Thorough soil investigations are required at sites of any engineering works.

Miscellaneous Land Types

No engineering data are available for these soils. Refer to the section "Description of the Soils" for information pertaining to them, and to the entries in Tables 21 and 22.

Table 20. Engineering classification of soils derived from water-laid deposits

Engineering description[a]	Soil series	Mode of deposition	USCS symbol[b]	Factors affecting use for foundations and earth structures	Est. permeability below 2-ft depth[d]
Layered gray clayey silts and silty clays	Acadia	Recent marine	ML CL (est.)	High water table, soft and compressible	Very slow
Reddish brown and yellowish red sands and gravels	Hebert	Glacial meltwater	GP GW		Very rapid
	Millar		GW GM SW SM	High water table (Millar)	Rapid
Brown to gray sands and gravels	Cumberland	Recent fluvial	GP	Sandy or gravelly	Very rapid
	Bridgeville		GW SP–SW (est.)	Periodic high water table	Very rapid
Dark gray to grayish brown clayey silts or silty clays	Chaswood	Recent fluvial or lacustrine	SM to CL (est.)	High water table, locally organic	Slow

[a] See the section "Description of the Soils" for more complete descriptions.
[b] Unified Soil Classification System (USCS).
[c] Factors other than those understood from the USCS.
[d] Estimates based on relatively few laboratory determinations, and observations of soil morphology in the field. See Table 19, note d.

Sand and Gravel

The soils are rated for suitability as sources of gravel in Table 21. The County has good-quality sand and gravel deposits. The largest deposits lie beneath the Cumberland, Bridgeville, and Hebert soils, which cover 37,000 acres. Hebert soils are the most extensive and on the whole have much lower potential for agriculture than Cumberland soils. Except where gravelly to the surface, Cumberland soils rate among the best for agriculture and in general their excavation for gravel should be discouraged because there are usually alternative sources close at hand. Hebert gravels are generally of higher quality and contain fewer sedimentary and weathered rocks and fewer fines.

A method used by highway engineers to evaluate the quality of gravel used as coarse aggregate in highway construction is the petrographic number. The determination is performed on the pass ¾ inch retained ⅜ inch sieve material, but if smaller sizes represent a reasonable percentage of the sample these are also used. After the examination, testing, and identification of each particle in the sample the constituent rock types are classified and weighed. They are grouped into good, fair, poor, and deleterious material and the percentage value for each group multiplied by factors of 1, 3, 6, and 10 respectively. The sum of the products is the basic petrographic number, so that uniformly high-quality (strong) material will have a value of 100 and the weakest a value of 1,000. The percentage of certain individual rock types in the poor and deleterious categories can be weighted by correction factors for specific intended uses, such as hot mix and mulch, concrete, and surface treatment chips, to give a corrected petrographic number.

For asphaltic surfacing material, the Nova Scotia Department of Highways tentatively rates a petrographic number of 100–125 as excellent, 125–140 good, 140–150 fair, and less than 150 poor.

In and around the Cobequid Mountains the gravels consist of very resistant rock types and analyses of many deposits gave petrographic numbers of 100 to 150, indicating a high suitability for road surfacing. Away from the mountains in the Cumberland Plain, only a few glaciofluvial deposits contain such strong gravelly materials.

The gravelly materials beneath Hebert and Cumberland soils were transported and deposited in fast-flowing water, and individual beds are commonly poorly graded (well sorted). But great vertical variations probably ensure reasonable grading in a mixed material from the same pit.

Sources of gravel abound in some of the glacial tills, where they are fairly well graded and generally contain fines. Each type of till supports different soil series and they are listed by soil series names in Table 21. The gravels are both stronger and more abundant in the soils of Group B than in Group C. More detail on the lithology of the materials can be found where the soil parent materials are discussed under "Description of the Soils."

Off-road Trafficability

The relative ease or difficulty of overland travel is closely related to the mapped soil series and phases, and an assessment is included here for those concerned with access and transportation away from roads. The soils are rated in three groups and the chief factors limiting trafficability are listed in Table 22.

Many of the soils are influenced by a perched water table; this means that the surface 12 inches of soil is maintained in a saturated state for a period of several

days, or in some cases weeks, after a rainfall (depending upon the time of year) because of the very slow permeability of the subsoil. Most of the soils have a dense subsoil with a high bearing capacity for large vehicles when undisturbed, but the layer is frequently too deep to benefit light vehicles, including four-wheel drive vehicles. A few soils do not have a strong subsoil and provide weak support for vehicles to depth. The Acadia, Chaswood, Millar, peat, Salt Marsh, large areas of Joggins, and some areas of Kingsville and Masstown soils belong to this group.

Table 21. Suitability of the soils as sources of gravel

Soil series or land type	Nature of gravel		
	Occurrence	Strength of particles	Remarks
Group A. Good			
Cumberland, Bridgeville	Abundant	Variable	Interbedded with sand and silt, often shallow to water table
Hebert	Abundant	Mostly strong, some weak	Some interbedding with sand
Group B. Fair			
Cobequid, Wyvern	Scattered deposits	Strong crystalline	Shallow, well graded, contains fines
Miller	Abundant	Strong and medium	Waterlogged, interbedded with sand
Rodney	Scattered deposits	Weak to medium	Shallow, contains fines, well graded
Rossway	Scattered deposits	Strong basalt	Contains fines, well graded
Coastal Beach	Abundant	Variable	Interbedded with sand, saline
Group C. Poor			
Economy, Chaswood	Very little	Weak to medium	Waterlogged
Hansford	Scattered deposits	Weak	Sandstone, well graded, contains fines
Kirkhill	Scattered deposits	Weak	Shale, shallow
Shulie, Springhill	Scattered deposits	Medium	Sandstone, contains fines
Westbrook	Scattered deposits	Medium to weak	Conglomerate, contains fines
Group D. Unsuitable			
Acadia, Debert, Diligence, Falmouth, Joggins, Kingsville, Masstown, Pugwash, Queens, Tormentine, Peat, Salt Marsh, Rocky Land			

Note: The rating in the table may not indicate accurately the suitability for concrete.

Table 22. Factors influencing off-road trafficability

Soil series or land type	Factors influencing off-road trafficability
Group A. Few limitations	
Hansford, Hebert, Pugwash, Tormentine	Steep slopes and stones in a few areas only
Group B. Fair	
Bridgeville	Periodic inundation or high water table, few trees, weak sandy subsoil
Cobequid, Wyvern	Boulders, steep slopes, bedrock outcrops
Cumberland	Periodic inundation, dries out rapidly, few trees, weak sandy subsoil
Debert	Perched water table over dense subsoil
Falmouth	Dense subsoil, slippery
Kirkhill	Steep slopes, boulders, rock outcrops
Queens	Perched water table, dense subsoil, slippery
Rodney, Rossway	Boulders, steep slopes, occasional rock outcrops
Shulie	Boulders, bedrock outcrops
Springhill	Perched water table, dense subsoil, boulders
Westbrook	Boulders, some steep slopes
Group C. Poor	
Acadia	Prolonged wetness, periodic inundation, slippery, slow drying, no trees
Chaswood	Continuous wetness, periodic inundation, boggy areas, slippery
Diligence	Perched water table, slippery, some boulders
Economy	Continuous wetness, boulders, some bedrock outcrops
Joggins, Kingsville	Prolonged wetness, perched water table, dense slippery subsoil
Masstown	Perched water table, dense sandy subsoil, prolonged wetness, boggy areas
Millar	Continuous high groundwater table, periodic inundation
Rocky Land	Rock outcrops, rough surface
Coastal Beach	Soft sand, stones
Peat	Extremely soft ground, permanently saturated
Salt Marsh	Continuous wetness, frequent inundation, slippery, soft

Note: The variations of stony and steeply sloping conditions across a soil series are shown on the soil map.

PART II

SOIL DEVELOPMENT AND CLASSIFICATION

Soil Formation and General Considerations

Soils and variations between soils are produced by the interaction of the factors of soil formation, namely, climate, living organisms (including vegetation), topography, parent materials, and time. Some of these topics have already been discussed in general; what follows relates their effect upon soils.

Climatic factors and microorganisms act upon rocks and parent materials to produce soils. The chemical reactions involved are more rapid at higher temperatures but depend upon the availability of adequate moisture. Rainfall and its excess over evapotranspiration are important in determining how rapidly the products of weathering, including plant nutrients, are leached down into, or out of, the soil profile. The climate of Cumberland County ensures rapid leaching and slow replacement with freshly weathered products; this is the basic reason for the acidity and infertility of the soils.

The effects of climate and vegetation are interwoven; climate exerts strong control over vegetation, and the vegetation modifies the climate at ground level. Climatic factors are partly responsible for an accumulation of organic matter in the soil, because the low temperatures during much of the year do not encourage rapid decomposition.

Plant nutrients brought from depth by plant roots enrich the surface through the eventual fall of litter, and tend to counter the downward removal of nutrients by leaching. However, the leaching ability is governed by the litter and is highest under coniferous and moss litter, somewhat less under hardwoods, and least under grasses. The litter cover also protects the soil from erosion.

Organic matter thoroughly incorporated into the mineral soil can produce good structure and the ideal combination of good moisture storage and rapid drainage of surplus water. Such conditions are approached under some deciduous trees and in surface soils under grass, where organic matter provides a source of N and a substrate for microorganisms. The microorganisms play a vital role in breaking down and synthesizing readily available plant nutrients. The farmer who applies lime not only increases the availability of present nutrients but stimulates a vastly increased microbial population, which helps produce them. Lime in combination with organic matter is necessary for a well-structured surface soil and deficiencies of one or the other are the cause of the weak structural aggregation of most cultivated soils in the province.

Coniferous trees drop a needle litter that is uninviting to most microorganisms and so it decomposes very slowly and builds up on the soil surface. This acid environment is also averse to earthworms and arthropods, so that little of this mor humus, as it is called, is mixed with the mineral soil. Infiltrating water is made acidic and readily leaches out plant nutrients and other bases.

The influence of topography is threefold. Elevation of the land affects temperature and rainfall and is therefore responsible for the greater leaching of upland soils, unless countered by other factors. The aspect of a slope in relation to the sun affects biological activity and the rate of weathering. But more important than these is the effect of slope upon the movement of water.

Water collects on level areas and is shed by slopes. On level areas, this leads to

gleying or intense leaching, or both, depending on the permeability of the soil and the level of groundwater. On slopes, even permeable soils tend to be less well developed, because a higher proportion of the rainfall is lost as runoff. Such water is not available for leaching but can erode the surface and keep the soil immature and often shallow.

Parent material determines the mineral content and, to a large extent, the texture of the soil. It partly governs soil fertility, internal drainage conditions, and color. Physical and chemical weathering together transform rocks into unconsolidated material; further alteration of minerals and the formation of secondary clay minerals rely increasingly on chemical processes. These processes proceed more rapidly in parent material containing high proportions of less resistant minerals, such as the ferro-magnesian minerals; where resistant quartz and orthoclase felspar are dominant, the soil usually has a fairly coarse texture. In all soils, much depends on whether decomposition products remain in the soil or are removed in drainage water.

The rate of weathering is highly variable and thus the formation of a soil depends on time. Given time, even resistant minerals break down and the soil may develop to great depth. Soils in the surveyed area have developed over the relatively short span of 10,000 years, since the close of the last Ice Age. Much of the initial weathering from rock to unconsolidated material was achieved rapidly by glacial action, or by extended preglacial and interglacial weathering under favorable warm humid conditions. Rather intense leaching since the Ice Age has produced soils that must be classed as fairly mature.

The most immature soils in the County are those forming on recent freshwater and marine alluvial deposits. These have periodically received fresh material from flooding and remain at a young stage of development.

Soil Classification

The present system of soil classification for Canada was adopted in 1960 and subsequently modified in the light of new knowledge. It consists of 8 orders, 22 great groups, 138 subgroups, 1,000 families, 3,000 series, and over 4,000 types (8).

All soils within a great soil group have a distinctive kind of profile, a unique arrangement of horizons, produced over broad areas by a particular kind of soil-forming environment. Within the great group there are regional variations in the nature and intensity of a particular horizon that permit the separation of subgroups. Orthic subgroups represent the central concept or the modal soil of the great group; other subgroups reflect significant modifications of the basic chemical processes prevailing in the soils. Many of them are soils that are far from the modal concept and intergrade to other great groups. Examples are the gleyed subgroups of the Dystric Brunisol great group in Cumberland County, which intergrade in a complex fashion with the Gleysol great group.

The soil series, the basic unit of mapping on the Cumberland County map, contains all the soils of a subgroup that have developed from the same parent material and possess similar profile characteristics such as texture, color, reaction, structure, and composition, within a defined range. They must have similar moisture regimes.

The 24 mineral soil series recognized on the Cumberland County map fall into 13 subgroups of 7 great groups. They are arranged in Table 23 to show their general relationships to one another. Subgroup names appear in italics. The soil series in

each horizontal row have evolved from the same kind of parent material but differ in drainage status (moisture regime). In any vertical column, i.e., drainage class, soils with parent material of similar texture within any subgroup have similar physical features and usually similar management requirements. The great group names are listed at the foot of the table.

A soil family is a group of series that have much in common in terms of physical and chemical composition. It allows the grouping of those series within a subgroup that have similar mineralogy, texture, reaction, soil climate, and problems associated with shallowness or fragipans, and it is rather less restrictive than a soil series. The soil family, with modifications, is a possible basis for the construction of a provincial soil map.

The grouping of the soils into families in Table 24 is tentative and the family names have not been officially adopted. Some of the family differentiating criteria are the same for all the soils and have been omitted from the table. Depth classes are applied only to lithic subgroups, which were mapped as undifferentiated rockland in Cumberland County. The pedoclimate class is assumed to be the same for all the soils, namely, "4.1d Mm Boreal cool perhumid, modified by Maritime influence" on the Soil Climatic Map of Canada (in preparation) or "frigid" in the USA system. The mineralogy of all the soils is mixed. Reaction is used as a family criterion for Gray Luvisols, Regosols, and Gleysols only, because it is understood in the subgroup classification for other soils.

The Formation of Soils in the Surveyed Area

In Cumberland County most of the well-drained soils are members of the Podzol great groups. The profile of a typical undisturbed Humo-Ferric Podzol soil is described under Tormentine Series. In this profile, Fe, Al, and organic matter have been precipitated in the B horizon. In some of the well-drained soils at higher elevations, such as those in the Cobequid Mountains, the upper B horizon may be somewhat darker and contains over 10% organic matter. These soils belong to the Ferro-Humic Podzol (formerly Humic Podzol) great group, and a description of a typical profile is given under the Cobequid Series.

Wherever natural soil drainage is restricted by the topography or slowly permeable layers in the subsoil, the soils remain wet for considerable periods and tend to develop duller colors than their well-drained counterparts. A mottled color pattern appears, which is a result of poor aeration and alternate reduction and oxidation of iron compounds in the presence of some organic matter. This is the process known as gleying. Where drainage is only imperfect, the soil may retain the basic characteristics of a podzol; the mottled layer is narrow and the podzolic B horizon may still be present but is thinner. Such soils are called Gleyed Podzols and they are rare in the surveyed area where podzolization appears to be drastically curtailed in conditions of imperfect drainage.

Wherever excessive water remains in the soil for a large part of the year, aeration is very poor and gleying becomes the dominant soil process. Colors tend to be low in chroma, and a substantial gley layer may occupy much of the profile. Mottling is frequently intense, but in some permanently waterlogged soils it may be faint due to a complete lack of oxygen and organic matter. Furthermore, the red color of many soils in the County partly masks the mottles. These poorly aerated soils are called Gleysols, and a typical example in the Orthic Gleysol subgroup is described under the Masstown Series.

Table 23. Classification of the mineral soils

Parent material	Rapidly drained	Well drained	Imperfectly drained	Poorly drained
		Orthic Ferro-Humic Podzol		
Shallow till derived from igneous and metamorphic rocks, olive brown gravelly sandy loam		Cobequid		
Shallow stony till derived from granite, brown to reddish brown gravelly sandy loam		Wyvern		
		Mini Ferro-Humic Podzol		
Shallow, cobbly till derived from Triassic basalt, brown to reddish brown sandy loam		Rossway		
	Orthic Humo-Ferric Podzol			*Orthic Gleysol*
Gravelly till derived from gray, brown, and red Carboniferous sandstones; pale reddish brown or yellowish red gravelly sandy loam	Hansford	Hansford		
Glaciofluvial sands and gravels, reddish brown or yellowish red, usually stratified	Hebert			Millar
Shallow gravelly till derived from shales, olive gray shaly gravel to shaly sandy loam		Kirkhill		
			Gleyed Degraded Dystric Brunisol	
Compact till derived from red and gray Carboniferous sandstones and shales, reddish brown sandy loam to loam		Pugwash	Debert	Masstown
Compact till derived from red Permo-Carboniferous micaceous sandstones, red sandy loam		Tormentine	Debert	Masstown
Shallow stony till derived from gray Carboniferous sandstones, grayish brown to reddish brown sandy loam to gravelly sandy loam		Shulie	Springhill	Economy
Compact gravelly till derived from gray Carboniferous sandstones, plus conglomerates and crystalline rocks; reddish or grayish brown gravelly sandy loam to gravelly loam		Rodney		
Till derived from Carboniferous conglomerates, reddish brown sandy loam to gravelly sandy loam		Westbrook		
		Orthic Gray Luvisol	*Gleyed Gray Luvisol*	*Low Humic Eluviated Gleysol*
Compact till derived from Carboniferous sandstones, shales, and mudstones, including calcareous material; reddish brown or red sandy clay loam to clay loam		Falmouth	Queens	Kingsville
Compact till derived from Carboniferous shales; reddish gray, grayish brown, or reddish brown sandy clay loam to silty clay			Diligence	

Table 23. Classification of the mineral soils (cont'd)

Parent material	Rapidly drained	Well drained	Imperfectly drained	Poorly drained
Compact till derived from Carboniferous shales, mudstones, and fine-grained sandstones; grayish brown clay loam				*Fera Eluviated Gleysol* Joggins
		Orthic Regosol	*Gleyed Regosol*	*Rego Gleysol*
Stream alluvium; sandy loam to loam, stratified sands and gravels		Cumberland	Bridgeville	
Marine sediments, reddish brown or dark gray silty clay loam to silty clay			Acadia	Acadia
Stream alluvium, silt loam to silty clay loam				Chaswood

Table 24. Soil family classification

Subgroup	Family	Series	Texture and special horizons	Reaction*	Slope %
Orthic Humo-Ferric Podzol	Tormentine	Hansford Pugwash Tormentine	Moderately coarse	a	2-9
	Westbrook	Rodney Shulie Westbrook	Moderately coarse over coarse-skeletal	a	2-15
	Hebert	Hebert	Moderately to very coarse	a	0.5-9
	Barney	Kirkhill	Medium over coarse-skeletal	a	5-30
Orthic Ferro-Humic Podzol	Cobequid	Cobequid Wyvern	Coarse-skeletal	a	5-30
Mini Ferro-Humic Podzol	Rossway	Rossway	Moderately coarse over coarse-skeletal	a	5-30
Gleyed Degraded Dystric Brunisol	Debert	Debert Springhill	Moderately coarse to medium, fragic	b	0.5-9
Orthic Gray Luvisol	Falmouth	Falmouth	Moderately fine	b	2-9
Gleyed Gray Luvisol	Queens	Queens Diligence	Moderately fine	b	2-9
Orthic Gleysol	Millar	Millar	Moderately to very coarse	a	0.5-5
	Aspotogan	Economy	Moderately coarse over coarse-skeletal	a	0.5-5
	Masstown	Masstown	Moderately coarse to medium, fragic	b	0.5-5
Rego Gleysol	Chaswood	Chaswood	Medium to moderately fine	a	0-2
Low Humic Eluviated Gleysol	Kingsville	Kingsville	Moderately fine	b	0.5-5
Fera Eluviated Gleysol	Joggins	Joggins	Moderately fine	b	2-9
Orthic Regosol	Cumberland	Cumberland	Moderately coarse to medium	b	0.5-5
Gleyed Regosol	Acadia	Acadia	Moderately fine	b	0-0.5
	Bridgeville	Bridgeville	Moderately coarse to medium	b	0-5

* a, acid; b, acid to neutral.

There are some soils that resemble the Podzols in having a light-colored leached (Ae) horizon when undisturbed, but have a B horizon (Bt) in which translocated clay is the main accumulation product. These belong to the Gray Luvisol great group, and a typical profile of the Orthic subgroup is described under the Falmouth Series. A profile of an imperfectly drained gleyed subgroup, which is more common in this County, is described under the Queens Series. Similar soils with clay-enriched B horizons, but that are poorly drained and intensively gleyed, are classified in the Eluviated Gleysol great group, and a profile description of the typical Low Humic Eluviated Gleysol subgroup can be found under the Kingsville Series.

There are undisturbed soils with a light-colored leached horizon and a B horizon with insufficient Fe, Al, organic matter, clay, or gleying to qualify as Podzols, Luvisols, or Gleysols. They are imperfectly drained over a compact subsoil or a fragipan and have been placed in the Dystric Brunisol great group. A description of a Gleyed Degraded Dystric Brunisol typical of this area appears under the Debert Series.

The water-laid sediments along streams and on the dykelands have not been in place long enough to develop marked soil horizons, except for a surface horizon. The soils on such materials are called Regosols, and typical profiles are described under the Cumberland Series (Orthic subgroup) and Acadia Series (Gleyed subgroup).

There are many wet depressions in the County, some of them possibly former lakes, in which organic material has accumulated. These display successive layers of mosses and sedges in varying degrees of decomposition, but lack horizons such as those found in a mineral soil. These soils are collectively classed as peat and fall chiefly into the Fibrisol and Mesisol great groups.

Humo-Ferric Podzol soils form the most extensive great group and cover 49% of the County. Gleyed Dystric Brunisols cover 17%, Gleysols 10%, Gray Luvisols 10%, Ferro-Humic Podzols 8%, and Regosols 2%.

The soils developed on glacial till occupy 91% of the land area of the County, and 60% of them are well drained, 28% imperfectly drained, and 12% poorly drained. The other mineral soils have developed on glaciofluvial deposits, stream alluvium, and tidal sediments. Most of the glaciofluvial soils are excessively drained; some of those on the stream alluvium are well drained and others are imperfectly or poorly drained. The soils of the tidal sediments are imperfectly, poorly, or very poorly drained.

Certain soils in Cumberland County have been the subject of pedological studies by McKeague and Cann (23), McKeague et al. (24,26), McKeague and Brydon (25), Brydon (4), and Brydon and Heystak (5). These papers present the results of research into the chemical and physical properties, mineralogy, micromorphology, and genetic processes of the soils.

Soil Profile Descriptions

This section contains detailed profile descriptions of all the soil series mapped in the County. Being specific to single sites the descriptions do not show the range of characteristics over the whole area of a mapped series, but in most cases they can be regarded as typical. For the range in characteristics refer to the generalized descriptions of the soils in Part I of this report and to the list of slope and stoniness phases in Table 25.

Analytical data for 15 of the profiles described in this section, representing soils covering 80% of the surveyed area, are given in Appendix II.

The soil colors and their notations in the descriptions are those of the standardized Munsell soil color charts. The colors are of soil in the moist state, except where the letter "d" after the Munsell notation indicates a dry color; in these cases the moist color is distinguished by the letter "m", e.g., 2.5Y 7/4m, 10YR 7/2d. Explanations of other technical terms are given in the glossary.

The pH values given with most of the detailed profile descriptions were determined electrometrically in the laboratory in a 1:1 water slurry or by using indicator solutions in the field.

ACADIA SERIES — *6.11/8 Gleyed Regosol*

SITE DESCRIPTION

Location	Amherst Marsh.
Parent material	Reddish gray to reddish brown silty clay loam tidal sediments reclaimed by dyking.
Drainage	Internal: imperfect. Site: slow.
Topography	Level, smooth, and stoneless; elevation 15 ft.
Vegetation and land use	Rough pasture, formerly used for hay. Agricultural capability 3DW.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
Ap	0 - 6	Dark reddish brown (5YR 3/3) silty clay loam; moderate, fine granular; friable, soft when dry; many, fine, interstitial pores; abundant, fine roots; abrupt, smooth boundary; pH 5.0.
Cg1	6 - 22	Reddish brown (5YR 4/3) silty clay loam; common, fine and medium, distinct, yellowish mottles, chiefly associated with root channels; weak, medium blocky; friable to firm; common, very fine, interstitial pores; plentiful, fine roots; gradual, smooth boundary; pH 6.4.
Cg2	22 - 36	Reddish brown (5YR 4/4) silty clay loam; common, fine and medium, distinct, yellowish mottles; weak, medium blocky to amorphous; few, very fine, interstitial pores; very few, fine roots; clear, smooth boundary; pH 7.5.
Cg3	36 - 42+	Reddish gray (5YR 5/2) silty clay loam; many, fine, prominent, yellowish mottles; amorphous; firm, plastic; few, very fine and fine, tubular pores; pH 3.5.

BRIDGEVILLE SERIES — *6.11/8 Gleyed Regosol*

SITE DESCRIPTION

Location	4 miles SE of Shinimicas Bridge.
Parent material	Brown sandy loam stream alluvium derived mainly from Carboniferous sandstones, and containing thin gravel lenses.
Drainage	Internal: imperfect. Site: slow to moderate, subject to seasonal inundation.
Topography	1% SW concave slope on margin of shallow depression; stoneless; elevation 25 ft.
Vegetation and land use	Hayfield. Agricultural capability 3IW.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
Ap	0 - 6	Brown (10YR 4/3m, 5.5/3d) loam; weak, fine subangular blocky; friable, hard; many, fine, interstitial and tubular pores; abundant, fine roots; gradual, smooth boundary; pH 6.1.
C	6 - 10	Brown (10YR 4/3m) fine sandy loam; common, fine, faint, yellowish red mottles; weak, fine subangular blocky; very friable; many, very fine, interstitial pores; abundant roots; abrupt, smooth boundary.
IIC	10 - 14	Stratified fine and medium gravel of mixed lithology and colors; single grain; loose; many, medium and coarse pores; few roots; abrupt, smooth boundary.
IIICg	14 - 38	Brown (7.5YR 4/4 rubbed moist) sandy loam; many, fine and medium, prominent, light olive brown, strong brown, reddish brown, and dark reddish gray mottles; intensity of mottling decreases slightly with depth; weak blocky to amorphous; friable, slightly sticky, hard; many, very fine pores; abundant, large, soft, black concretions of MnO_2; pH 5.5.

CHASWOOD SERIES — *7.22 Rego Gleysol*

SITE DESCRIPTION

Location	North Greenville, 0.5 mile E of railroad crossing.
Parent material	Grayish brown to dark gray laminated stream alluvium of silt loam and silty clay loam texture, resting on sand and gravel. Stoneless.
Drainage	Internal: very poor. Site: very slow, subject to inundation.
Topography	Level floor of shallow depression in stream floodplain; elevation 240 ft.
Vegetation and land use	Sedges, rushes, and scattered alder bushes. Agricultural capability 5IW.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
Ahg	0 - 10	Dark grayish brown (2.5Y 4/2) silt loam; few, medium, distinct, light olive brown (2.5Y 5/6) mottles; moderate, medium granular; friable, slightly plastic; many, fine pores; abundant roots; clear, wavy boundary.
Cg	10 - 45	Grayish brown (2.5Y 5/2) silt loam to silty clay loam; many, medium and coarse, distinct, yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) mottles; weak, coarse blocky to amorphous; firm, sticky, hard; few, fine, tubular pores; very few roots; clear, smooth boundary.
IICg	45 - 50	Dark gray (2.5Y 4/0) silty clay loam; amorphous; very firm, hard, sticky; abrupt, smooth boundary.
IIICg	50+	Laminated sand and gravel.

COBEQUID SERIES — *4.21 Orthic Ferro-Humic Podzol*

SITE DESCRIPTION

Location	2 miles N of Sutherlands Lake.
Parent material	Olive brown gravelly and stony sandy loam to loamy sand till derived from a mixture of hard crystalline and metamorphic rocks, including granite, diorite, syenite, and felsite.
Drainage	Internal: good. Site: rapid.
Topography	7% uneven N slope; surface very hummocky due to windthrow, and very stony; elevation 920 ft.
Vegetation and land use	Medium to young maple regrowth, a few birch, and understory of bracken and ferns. Agricultural capability 7P.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	2 - 0	Moder. L – 0.5 inch of broad-leaved and twig litter; 1.5 inches of mixed F and H with abundant, washed mineral grains; some earthworms, many faunal droppings; clear, smooth boundary; pH 4.1.
Ae	0 - 1	Reddish gray (5YR 5/2) silt loam; weak, fine subangular blocky and single grain; very friable; many, very fine, interstitial and tubular pores; abundant, fine and medium roots; several earthworms; coatings of organic matter along old root channels; abrupt, smooth boundary; pH 3.8.
Bhf	1 - 5	Yellowish red (5YR 4/8) very fine sandy loam; moderate, fine granular; soft and crumblike, friable; many, fine and medium, interstitial pores; abundant, fine roots; several earthworms; gradual boundary; pH 4.5.
Bfh	5 - 13	Dark brown (7.5YR 4/4) fine sandy loam; moderate, fine subangular blocky; friable; many, very fine, interstitial pores; abundant, medium and fine roots; some old root channels filled with pale-colored Ae-type material and organic coatings; 20% subangular cobbles; gradual boundary; pH 4.9.
BC	13 - 19	Light olive brown (2.5Y 5/4) loamy fine sand; single grain; loose; many, fine and medium pores; few roots; 30% cobbles and stones; diffuse boundary; pH 5.3.
C	19 - 32+	Light olive brown (2.5Y 5/4) gravelly loamy sand till; loose; many, very fine pores; very few roots; 50% cobbles and stones; pH 5.3.

CUMBERLAND SERIES

6.11 Orthic Regosol

SITE DESCRIPTION

Location	River Philip Centre, east side of floodplain.
Parent material	Brown stream alluvium of sandy loam over coarse sand, derived from Carboniferous sandstones and igneous and metamorphic rocks.
Drainage	Internal: moderately good. Site: slow to moderate, subject to occasional inundation.
Topography	1% even W slope; stoneless; elevation 100 ft.
Vegetation and land use	Arable field. Agricultural capability 3I.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
Ap	0 - 7	Brown (7.5YR 4.5/4) sandy loam; weak, fine granular; very friable; common, very fine pores; abundant, fine roots; abrupt, smooth boundary; pH 5.0.
C	7 - 25	Brown (7.5YR 4.5/4) sandy loam; single grain; very friable to loose; common, very fine pores; plentiful to abundant, fine roots; gradual, smooth boundary; pH 5.2.
Cgj	25 - 31	Brown (7.5YR 5/4) sandy loam; common, fine, faint, yellowish mottles; otherwise similar to horizon above; gradual, smooth boundary; pH 5.0.
IICg	31 - 43	Brown (7.5YR 5/4) coarse sand; many, fine, faint, pale grayish brown mottles; single grain; loose.

DEBERT SERIES — *5.42/8 Gleyed Degraded Dystric Brunisol*

SITE DESCRIPTION

Location	2 miles E of Amherst Head, N side of Route 6.
Parent material	Dark red to reddish brown compact sandy loam till derived from red micaceous Permo-Carboniferous sandstones.
Drainage	Internal: imperfect. Site: slow.
Topography	1–2% even S slope, with hummocky surface due to windthrow; slightly stony; elevation 90 ft.
Vegetation and land use	High forest of red and black spruce, with a few balsam fir; open floor with continuous sphagnum and hypnum mosses. Agricultural capability 3d.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	3 - 0	1 to 2 inches of hypnum and sphagnum mosses, ferns, spruce needles, and broad leaves over a thin F layer; 1- to 2-inch H layer with some admixture of mineral grains; some fungal hyphae; abrupt, smooth boundary; pH 4.0.
Aeg	0 - 9	Light gray (10YR 7/2) very fine sandy loam; common, medium, distinct but diffuse, pale brown (10YR 6/3) mottles in lower part of horizon; moderate, medium platy; very friable; many, very fine, interstitial and tubular pores; plentiful roots of all sizes; clear, wavy boundary; pH 4.2.
Bfg	9 - 11	Yellowish red (5YR 4/6) very fine sandy loam; many, fine, distinct, strong brown (7.5YR 5/5) mottles; strong, coarse platy; firm to very firm, hard and brittle; weakly cemented; many, very fine, interstitial pores and horizontal planar voids; plentiful roots; horizon penetrated by light gray (10YR 7/2) 1 inch wide fracture planes, 18 inches apart or more; abrupt, wavy boundary; pH 4.5.
Bx	11 - 22	Dark red (2.5YR 3/6) very fine sandy loam; strong, fine to medium platy; firm, hard and brittle; common, very fine, interstitial and vesicular pores; few, fine roots confined to fracture planes; light gray fracture planes extend from above; gradual boundary; pH (11 to 16 inches) 5.0, (16 to 22 inches) 4.7.
C	22 - 36	Dark red (2.5YR 3/6) very fine sandy loam; weak, coarse pseudoblocky tending to amorphous, but penetrated by bleached fracture planes to bottom of profile; firm, very few roots; pH 5.7.

DILIGENCE SERIES ***3.21/8 Gleyed Gray Luvisol***

SITE DESCRIPTION

Location	0.5 mile E of Riverside Beach, Parrsboro, on N side of road to Greenhill.
Parent material	Reddish brown clay loam to sandy clay loam till derived mainly from Carboniferous shales.
Drainage	Internal: imperfect. Site: moderate.
Topography	4% even SW slope with moderately hummocky and moderately stony surface; elevation 160 ft.
Vegetation and land use	Forest of red spruce, with some balsam fir, birches, and maples. Understory of ferns, broad-leaved and hypnum mosses, with patches of sphagnum. Agricultural capability 4D.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	3 – 0	1 to 2 inches of litter containing hypnum and sphagnum mosses, ferns, spruce needles, and broad leaves over a thin F layer; 1- to 2-inch Hi; some fungal hyphae; abrupt, smooth boundary; pH 4.0.
Ae	0 – 1	Light reddish brown (5YR 6/3) silty clay loam; common, medium, faint and diffuse mottles; ped surfaces lighter colored; strong, medium granular and weak, medium subangular blocky; firm, sticky and slightly plastic, hard; abrupt, smooth boundary; pH 4.2.
ABg1	1 – 7	Reddish brown (5YR 5/4) silty clay loam; common, fine and medium, prominent, strong brown (7.5YR 5/8) mottles; moderate to strong, medium subangular blocky; friable, sticky, hard; common, very fine, interstitial pores; abundant roots, few, thin clay films; horizon 5–7 inches thick; may be old plow layer; clear, wavy boundary; pH 4.6.
ABg2	7 – 12	Reddish brown (5YR 4/3) sandy clay loam; many, large, distinct brown (7.5YR 5/2) and prominent strong brown (7.5YR 5/8) mottles; weak, coarse subangular blocky; sandy pockets; friable, slightly sticky, hard; common, very fine, interstitial pores; 10% gravel and cobbles; few, thin clay films; clear, wavy boundary; pH 5.2.
Btgj	12 – 38	Reddish brown (5YR 4/4) clay loam; common, medium and coarse, distinct, yellowish red (5YR 5/6) mottles; weak, coarse subangular blocky to amorphous; plastic, hard to very hard; dense, compact and impermeable; common, thin clay films; gradual boundary; pH 5.3.
C	38 – 42+	Reddish brown (5YR 4/4) clay loam; faint mottles are probably of lithological origin; amorphous; dense and impermeable; common, small shale fragments; pH 5.5.

ECONOMY SERIES — *7.21 Orthic Gleysol*

SITE DESCRIPTION

Location	2 miles NE of East Apple River.
Parent material	Reddish gray stony and compact gravelly sandy loam till derived from hard, gray Carboniferous sandstones.
Drainage	Internal: poor. Site: slow.
Topography	2% uneven W slope with hummocky and very stony surface; elevation 425 ft.
Vegetation and land use	Patchy open forest of black spruce, with some balsam fir and red spruce; understory of ferns and Labrador tea, with thick moss carpet. Agricultural capability 7P.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
Of	5 - 0	Fibric peaty mor, derived from sphagnum mosses, coniferous needles, and herbaceous litter, 1-inch discontinuous H layer.
Aeg	0 - 7	Light gray (5Y 7/2) sandy loam; common, fine, prominent, yellow (10YR 7/6) mottles; patches of grayish brown organic staining in the upper few inches; single grain; loose; plentiful, fine roots; gradual, smooth boundary; pH 4.0.
Bg or Bxjg	7 - 22	Reddish brown (5YR 4/3) sandy loam; weak, coarse platy; firm and compact; very few, fine roots; 25% subangular and angular sandstone pebbles and cobbles; diffuse boundary; pH 4.7.
C	22 - 36+	Dark reddish gray (5YR 4/2) gravelly sandy loam; amorphous; firm and compact; 40% pebbles and cobbles; pH 5.0.

FALMOUTH SERIES — *3.21 Orthic Gray Luvisol*

SITE DESCRIPTION

Location	1 mile W of Thomson Station.
Parent material	Reddish brown compact, weakly calcareous sandy clay loam till derived from Carboniferous red and gray sandstones, shales, and mudstones.
Drainage	Internal: moderately good. Site: moderately rapid.
Topography	5% even S slope with a hummocky and moderately stony surface; elevation 210 ft.
Vegetation and land use	Medium-aged second-growth forest of red spruce and balsam fir. Agricultural capability 3D.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	4.5 - 0	Raw moder, 1-inch L, 2.5-inch F, 1-inch Hi; mainly mosses and needles; Hi layer discontinuous; the whole bound by fungal hyphae; abrupt, wavy boundary.
Ahe	0 - 2	Dark grayish brown (10YR 4/2) loam; bleached mineral grains thoroughly mixed with organic matter; darker streaks penetrate from top and paler streaks from below; moderate, fine subangular blocky; friable; many, very fine pores; abundant roots; few earthworms and casts; few, charred wood fragments; clear, smooth boundary.
Aegj	2 - 7	Yellowish brown (10YR 5/4) silt loam; common, fine, faint, reddish mottles; weak, fine subangular blocky and moderate, medium platy; very friable; many, micro pores; few roots; gradual, smooth boundary.
Bfh or Bm	7 - 10	Yellowish red (5YR 5/6) sandy clay loam; moderate, fine subangular blocky; friable; many, fine pores; plentiful roots; clear, smooth boundary.
Bt	10 - 22	Reddish brown (5YR 4/3) sandy clay loam; moderate, medium platy; firm; many, fine pores and horizontal planar voids; few roots; many, thin clay films; few, small, soft, black concretions of MnO_2; gradual, smooth boundary.
C	22 - 30+	Reddish brown (5YR 4/3) sandy clay loam; moderate, pseudoblocky; firm and compact; few, very fine pores.

HANSFORD SERIES — *4.31 Orthic Humo-Ferric Podzol*

SITE DESCRIPTION

Location	1 mile N of Conns Mills on the road to Pugwash.
Parent material	Reddish brown sandy loam to gravelly sandy loam till derived from Carboniferous gray and red sandstones.
Drainage	Internal: good. Site: rapid and shedding.
Topography	5% convex W slope with hummocky and moderately stony surface; elevation 45 ft.
Vegetation and land use	Medium-aged forest of red spruce, with some balsam fir, hemlock, and maple. Open floor with some ferns, tree seedlings, and patchy mosses. Agricultural capability 3TP.
Note	This soil is unusual in having a discontinuity in the parent material at a depth of 19 inches; the lower layer is much darker in color than normal in Hansford soils.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	3 - 0	Raw moder transitional to felty mor; mainly semidecomposed mosses and needles with an admixture of H material and thin L layer; permeated by fungal hyphae; abrupt, smooth boundary; pH 4.3.
Ae	0 - 4	White (2.5Y 8/2) loamy fine sand; single grain; loose; many, micro, interstitial pores; abundant roots; clear, wavy boundary; pH 4.4.
Bfh	4 - 8	Yellowish red (5YR 5/8) fine sand; weak, fine granular; very friable; many, very fine, interstitial pores; abundant roots; gradual, smooth boundary; pH 4.7.
Bf	8 - 16	Strong brown (7.5YR 5/8) loamy fine sand; moderate, fine subangular blocky and granular; friable; common, fine, interstitial and vesicular pores; few roots; gradual, smooth boundary; pH 5.3.
BC	16 - 19	Dark reddish brown (5YR 3/4) fine sand; single grain; very friable but quite compact; common, micro, interstitial pores; 20% sandstone pebbles and small cobbles; clear, smooth boundary; pH 5.6.
IIC	19 - 34	Dark reddish brown (2.5YR 3/4) gravelly fine sandy loam; moderate, medium pseudoblocky; friable but quite compact; many, fine, interstitial pores; very few roots in upper part; 40% sandstone pebbles, cobbles, and flags of all sizes, some of manganiferous sandstone; pH 6.1.

HEBERT SERIES — *4.31 Orthic Humo-Ferric Podzol*

SITE DESCRIPTION

Location	0.5 mile SE of Conns Mills.
Parent material	Reddish brown to yellowish red stratified outwash sands of mixed origin.
Drainage	Internal: rapid. Site: rapid.
Topography	4% convex N slope, elevation 35 ft.
Vegetation and land use	Old pasture. Agricultural capability 4M.
Note	A thin cemented Bfc (ortstein) horizon was observed in several Hebert profiles but is not typical of the series as a whole.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
Ap	0 - 4	Grayish brown (10YR 5/2d) sandy loam; strong, fine subangular blocky; friable; many, fine, tubular and interstitial pores; abundant roots; abrupt, smooth boundary; pH 4.9.
Ae	4 - 14	Pinkish white (7.5YR 8/2d) loamy sand; single grain; loose; many micro, interstitial pores; few roots; abrupt, smooth boundary; pH 4.3.
Bfh	14 - 16	Yellowish red (5YR 4/6m) loam; moderate, fine subangular blocky or crumblike; friable; many, very fine, interstitial pores; plentiful, very fine roots; clear, smooth boundary; pH 4.7.
Bfc	16 - 22	Yellowish red (5YR 4/7m) loamy sand; moderate, coarse platy; strongly cemented by iron compounds; hard and brittle; many, very fine pores of all types; clear, smooth boundary; pH 4.8.
C	22+	Reddish brown to yellowish red (5YR 4/5m) sand; single grain; loose; many, interstitial pores; pH 4.6.

JOGGINS SERIES — *7.32 Low Humic Eluviated Gleysol*

SITE DESCRIPTION

Location	1 mile E of Joggins, 0.25 mile W of junction on Joggins - River Hebert road.
Parent material	Dark grayish brown clay loam till derived mainly from shales and fine-grained gray and red sandstones of the Carboniferous Coal Measures.
Drainage	Internal: poor. Site: slow.
Topography	Less than 1% E slope with moderately hummocky surface due to windthrow; slightly stony; elevation 210 ft.
Vegetation and land use	Low poor-quality forest of balsam fir, black spruce, red spruce, maples, and some birch; understory of ferns, tree seedlings, and mosses. Agricultural capability 4DW.
Note	Joggins soils are generally believed to be Fera Eluviated Gleysols (7.33), but analysis of samples from this site disclosed insufficient accumulation of Fe in the B horizon. This site was used by McKeague et al in 1971 (26).

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	4 - 0	1-inch L layer of mixed broad leaves, needles, mosses, and twigs; 2-inch F layer merges into 1 inch of mixed F and Hi material; abrupt, smooth boundary.
Aeg1	0 - 3.5	Light gray (10YR 7/1) loam; weak, medium platy, within very coarse humus-coated prisms; loose to very friable; many, very fine, interstitial pores; plentiful, fine roots; clear, wavy boundary.
Aeg2	3.5 - 5.5	Light gray (10YR 7/1) and light brownish gray (2.5Y 6/2) fine sandy loam; many, medium, prominent, brownish yellow mottles and medium, faint, yellowish brown mottles; weak, medium subangular blocky, within very coarse humus-coated prisms; very friable; many, very fine, vesicular pores; few, fine roots; horizon 2 to 4 inches thick; clear, tongued boundary.
Btg	5.5 - 10	Yellowish brown (10YR 5.5/4 moist rubbed) loam; many, fine and medium, prominent, brown, strong brown, and reddish yellow inped mottles and light brownish gray (10YR 6/2) exped mottles; moderate, medium subangular blocky, within strongly developed, very coarse prisms; few, fine, vertical and horizontal planar voids; many, thin clay films; humus-staining and washed sand grains in some vertical planar voids; very firm, very hard, sticky; very few, fine roots; common, fine, irregular, black concretions of MnO_2; 15% rounded and subangular pebbles; gradual, smooth boundary.
IIBCg	10 - 15	Dark brown to brown (10YR 4/3) silty clay loam; common, fine, faint, yellowish brown mottles, and pinkish gray (7.5YR 6/2) ped surfaces; compact, amorphous matrix within strongly developed, very coarse prisms; very firm, very hard, very sticky; few, very fine, vesicular pores; very few roots; few, thin clay films on ped faces; 10% small, subangular sandstone pebbles; common, fine, black MnO_2 concretions; diffuse boundary.

IIC	15 - 28	Dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) on structure faces; many, fine, olive specks of weathered sandstone; amorphous, penetrated by occasional vertical fracture planes, lined with thin clay films; very firm, very hard, very sticky; few, fine, vesicular and tubular pores, the latter containing thin clay films; very few roots; 20% angular and subangular sandstone, shale, and coal pebbles.

KINGSVILLE SERIES — *7.32 Low Humic Eluviated Gleysol*

SITE DESCRIPTION

Location	2 miles W of Oxford Junction.
Parent material	Reddish brown compact sandy clay loam till derived from Carboniferous sandstones, shales, and mudstones; weakly calcareous.
Drainage	Internal: poor. Site: slow.
Topography	Less than 1% slope on floor of shallow depression with hummocky and slightly stony surface; elevation 170 ft.
Vegetation and land use	Low, open, second-growth forest of balsam fir, red spruce, and black spruce, with a few maple and larch. Agricultural capability 5DW.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	3 - 0	Peaty mor. Mostly L and F, with negligible H material; abrupt, smooth boundary.
Aeg	0 - 7	Light gray (10YR 7/1) sandy loam; single grain to weak, fine platy; friable; many, very fine, interstitial pores; plentiful roots; abrupt, smooth boundary.
Bg	7 - 13	Reddish brown (2.5YR 4/3) loam; many, medium and coarse, prominent, strong brown (7.5YR 5/8) mottles; moderate, medium granular; friable; many, very fine, interstitial pores; few, fine roots; clear, smooth boundary.
Btg	13 - 24	Reddish brown (2.5YR 4/3) sandy clay loam; common, medium prominent, yellowish brown (10YR 5/6) mottles; amorphous and dense; firm; few, vesicular pores and grayish, vertical fracture planes; common, thin clay films; common, soft, black manganiferous concretions; gradual boundary.
C	24 - 30+	Reddish brown (2.5YR 4/3) sandy clay loam; amorphous and dense; firm.

KIRKHILL SERIES — *4.31 Orthic Humo-Ferric Podzol*

SITE DESCRIPTION

Location	3 miles N of Spencers Island off the Allen Hill road.
Parent material	Olive gray shaly till derived from Carboniferous gray shales, thinly covering shale bedrock.
Drainage	Internal: good. Site: moderate to rapid.
Topography	1% to 2% slightly convex E slope with hummocky and moderately stony surface; elevation 575 ft.
Vegetation and land use	Medium-quality forest of balsam fir, red spruce, birches, and maples, with a moderately dense understory of ferns, tree seedlings, and shrubs, and abundant mosses and wood-sorrel. Agricultural capability 4RP.
Note	Kirkhill soils intergrade to Orthic and Mini Ferro-Humic Podzols. (4.21, 4.22), as indicated by this profile.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	3 - 0	Raw moder. 0.5-inch L and 1.5-inch F of mixed origin; 1-inch Hi layer, black, well-decomposed, somewhat fluffy, with mineral grains; root-bound; abrupt, irregular boundary; pH 4.5
Ae	0 - 1	Light olive brown (2.5Y 5/4m, 7/2d) silt loam; moderate, crumblike, fine granular; friable, slightly sticky; many, fine, interstitial pores; plentiful roots; discontinuous horizon; darker patches of H incorporation common; abrupt, wavy boundary; pH 4.1.
Bhf	1 - 4	Dark reddish brown (2.5YR 2.5/4m, 7.5YR 5/4d) loam to sandy loam; strong, crumblike, fine granular; friable; many, fine, interstitial pores; abundant roots; clear, smooth boundary; pH 4.2.
Bfh	4 - 8	Reddish brown (5YR 3/4m, 7.5YR 5/4d) gravelly sandy clay loam to loam; weak, fine subangular blocky and fine granular; friable; many, very fine, interstitial pores; abundant roots; 30% shaly, fine gravel and stones; clear, smooth boundary; pH 4.1.
Bf1	8 - 17	Olive yellow (2.5Y 6/6m) shaly, gravelly coarse sandy loam, with patches of light olive brown (2.5Y 5/4m) and yellowish brown (10YR 5/4m) (10YR 7/3 dry rubbed); weak, fine subangular blocky and single grain; loose; many, fine and medium, interstitial pores; few roots; 60% shale gravel; abrupt, wavy boundary; pH 5.2.
Bf2	17 - 19	Dark brown (7.5YR 4/4m), shaly, gravelly sandy loam; common, medium, distinct, yellowish brown (10YR 5/6m) mottles (10YR 6/6 dry rubbed); weak, fine subangular blocky and single grain; very friable to loose; many, fine, interstitial pores; 60% shale gravel; variable discontinuous horizon; abrupt, wavy boundary; pH 5.2.
C	19 - 32	Olive gray (5Y 4/2m), shaly, gravelly loamy coarse sand; single grain; loose; many, fine and medium, interstitial pores; 80% shaly gravel and stones; larger fragments increase regularly downwards; clear, wavy boundary; pH 5.0.

IIC	32 - 35	Olive (5Y 5/3m), shaly, very gravelly loam to silt loam; common, fine, distinct, yellowish mottles (5Y 6/1 dry rubbed); loose; soft, weathered shale bedrock, 80% shaly gravel and stones.

MASSTOWN SERIES — *7.21 Orthic Gleysol*

SITE DESCRIPTION

Location	West Pugwash crossroads, 2 miles W of Pugwash on Route 6.
Parent material	Reddish brown compact fine sandy loam till derived mainly from Carboniferous red sandstones.
Drainage	Internal: poor. Site: very slow and receiving.
Topography	Almost level with low broad surface hummocks; stoneless; elevation 45 ft.
Vegetation and land use	Fairly mature stand of black and red spruce, with some birches; open floor with little understory; may have been cultivated formerly. Agricultural capability 4Wd.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	3 - 0	Moder. 1 inch of needle and moss litter over 2 inches of mixed F and H material; incipient discontinuous Hi layer; abrupt, smooth boundary; pH 4.3.
Aeg	0 - 9	Very pale brown (10YR 8/3) loam; many, fine, prominent but diffuse, yellow (10YR 8/6) mottles; weak, fine platy; very friable to loose; many, very fine, interstitial pores; abundant roots in upper 5 inches; abrupt, irregular boundary; pH 4.7.
Bgfj or Bg	9 - 13	Yellowish red to reddish brown (5YR 5/5) very fine sandy loam; many, fine, prominent, brownish yellow (10YR 6/6) mottles; moderate to weak, fine platy, within coarse prisms formed by 0.75-inch-wide vertical fracture planes containing Aeg material; friable; many, very fine, interstitial pores; few roots; abrupt, irregular, tongued boundary; pH 4.9.
Bxg	13 - 20	Reddish brown (2.5YR 4/4) fine sandy loam; many, medium, faint, yellowish mottles; moderate, medium platy; firm and compact, hard; many, very fine, interstitial and vesicular pores; very few roots; vertical fracture planes 18 inches apart extend through this horizon to bottom of profile; gradual boundary; pH 5.1.
Bxj	20 - 29	Reddish brown (2.5YR 4/4) fine sandy loam; weak, medium platy tending to amorphous but penetrated by vertical gray fracture planes; friable to firm, and compact; few, micro interstitial pores; gradual boundary; pH 5.1.
C	29 - 40	Reddish brown (2.5YR 4/4) very fine sandy loam; amorphous but penetrated by gray fracture planes; friable to firm, and compact; few micro interstitial pores; pH 5.3.

MILLAR SERIES — *7.21 Orthic Gleysol*

SITE DESCRIPTION

Location	2 miles SW of West Brook.
Parent material	Dark reddish brown stratified outwash sands of mixed origin.
Drainage	Internal: poor. Site: slow, with permanent high water table.
Topography	Level valley floor, elevation 75 ft.
Vegetation and land use	Birch and alder scrub with dense ground flora of sheep-laurel, Labrador tea, leatherleaf, and sedges. Agricultural capability 5W.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	3 - 0	Black greasy mor or humic peaty mor; very little L or F material; abrupt, smooth boundary.
Aeg	0 - 8	Light brownish gray (2.5Y 6/2) sandy loam; single grain; loose; many, very fine pores; plentiful, fine roots; abrupt, smooth boundary.
Bfg	8 - 12	Strong brown (7.5YR 5/8) sandy loam or silt loam; common, distinct, yellowish mottles; amorphous; friable; common, very fine pores; plentiful, fine roots; abrupt, smooth boundary.
BCg	12 - 18	Distinctly mottled strong brown (7.5YR 5/8) and reddish brown (5YR 4/4) sandy loam; single grain; loose; many, very fine pores; abrupt, smooth boundary.
Cg	18+	Dark reddish brown (5YR 3/4) sand; single grain; loose; saturated.

PUGWASH SERIES — *4.31 Orthic Humo-Ferric Podzol*

SITE DESCRIPTION

Location	1 mile N of Mount Pleasant.
Parent material	Reddish brown compact loamy till derived mainly from Carboniferous red sandstones, with some shales and gray sandstones.
Drainage	Internal: moderately good. Site: moderate to slow.
Topography	2% even N slope; slightly stony surface; elevation 400 ft.
Vegetation and land use	Run-down, poor-quality pasture field. Agricultural capability 2FC.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
Ap	0 - 6	Reddish brown (5YR 4/4) loam; strong, medium subangular blocky and coarse granular; friable; many, fine pores; abundant roots; many earthworms; clear, smooth boundary; pH 4.6.
Bf	6 - 13	Yellowish red (5YR 4/6) loam; moderate, fine granular and weak, fine subangular blocky; friable; many, fine pores; abundant roots; a few earthworms; clear, smooth boundary; pH 5.0.
Bxj or Bm	13 - 19	Yellowish red (5YR 4/6) loam; moderate, coarse platy, within light gray vertical fracture planes spaced at 24 inches and extending to bottom of profile; firm; common, very fine pores; plentiful roots; clear, smooth boundary; pH 5.0.
Bx	19- 23	Reddish brown (2.5YR 4/4) loam; strong, coarse platy; firm to very firm, sticky, hard and brittle; few, very fine pores; very few roots; few, thin clay films; clear, smooth boundary; pH 5.0.
C	23 - 32+	Reddish brown (2.5YR 4/4) loam; weak, coarse platy and coarse blocky; firm and compact, sticky; 15% coarse sandstone pebbles and cobbles; pH 4.8.

QUEENS SERIES — *3.21/3/8 Gleyed Brunisolic Gray Luvisol*

SITE DESCRIPTION

Location	1 mile NE of Pugwash Junction.
Parent material	Reddish brown compact loam-textured till derived from Carboniferous, fine-grained, red sandstones, shales, and mudstones; weakly calcareous.
Drainage	Internal: imperfect. Site: slow.
Topography	2% N slope with a hummocky and slightly stony surface; elevation 100 ft.
Vegetation and land use	Medium-height forest of red spruce, with a few birch, a thin understory of tree seedlings and herbs, and abundant mosses. Agricultural capability 4D.
Note	This soil contains 2% to 7% less clay than most Queens soils, which are usually sandy clay loams. Although possessing most of the characteristics of Queens soils, it is marginal to the Debert soils, which lack significant clay illuviation. The site was used by McKeague et al. (23, 24, 25).

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	2.5 - 0	1-inch needle and moss litter; 1.5-inch F layer; H layer incipient and discontinuous; abrupt, smooth boundary.
Ahe	0 - 4	Grayish brown (10YR 5/2m, 6/1.5d) loam; moderate, medium granular; very friable, hard; many, fine pores; abundant roots; clear, wavy boundary; pH 4.0.
Aeg1	4 - 7	Light brownish gray (10YR 6/2m, 7/2d) loam; many, medium, distinct, yellowish brown (10YR 6/4m) mottles; weak, fine platy; friable; common, very fine pores; plentiful roots; some patches of organic staining at top; clear, wavy boundary.
Aeg2	7 - 10	Light brownish gray (10YR 6/2m, 7/2d) fine sandy loam; common, medium and coarse, distinct and prominent, light yellowish brown to brownish yellow (10YR 6/4 to 6/6m) mottles; moderate, medium platy; gray silt caps on some plates; friable, slightly hard; few roots; clear boundary.
Btjg1	10 - 13	Brown (7.5YR 5/4m, 6/4d) loam; many, fine, distinct, brownish yellow (10YR 6/6m) and strong brown (7.5YR 5/6m) mottles; many peds coated pinkish gray (7.5YR 6.5/2m); moderate, medium platy; firm, hard; common, fine pores; few roots; few, thin clay films coating peds and lining pores; common, black specks of MnO_2; clear, wavy boundary; pH 4.4.
Btjg2 or Bxjg	13 - 19	Reddish brown to dark reddish brown (5YR 3.5/3.5m, 5/4d) sandy loam; common fine, distinct, yellowish red (5YR 4/6m) mottles and few, faint, grayish mottles; few, fine, reddish brown (5YR 5/3m, 7.5YR 5/4d) vertical fracture planes; moderate, coarse platy; firm, hard, sticky; common, very fine pores; very few roots; many, fine, soft black concretions of MnO_2; common, thin clay films; clear, wavy boundary; pH 4.7.

Bt	19 - 21	Reddish brown to dark reddish brown (5YR 3.5/3.5m, 5/4d) sandy loam; amorphous to weak, coarse subangular blocky; firm, hard, sticky; very compact; common, very fine pores; very few roots, concentrated in fracture planes; common, thin clay films; 15% subangular sandstore gravel; gradual boundary; pH 5.7.
BC	21 - 26	Similar to above horizon except for fewer clay films, loam texture, and some manganiferous coatings.
C1	26 - 40	Similar to above horizon, except for amorphous structure; few clay films; soft MnO_2 concretions decrease with depth.
Ck	40 - 60	Dark reddish brown (4YR 3/4m, 5/4d) loam; amorphous breaking to coarse pseudoplaty; firm, very hard; common, black manganiferous coatings; weakly calcareous; few stones; few pores; no roots.

RODNEY SERIES — *4.21 Orthic Ferro-Humic Podzol*

SITE DESCRIPTION

Location	3 miles N of Westchester.
Parent material	Reddish brown gravelly sandy loam till mainly derived from Carboniferous gray sandstones and red conglomerate, with some acid igneous material.
Drainage	Internal: good. Site: rapid.
Topography	8% convex W slope with hummocky surface due to windthrow; very stony surface; elevation 450 ft.
Vegetation and land use	Medium-height forest of red spruce, with some birch; open floor with profuse mosses. Agricultural capability 7P.
Note	Most of the Rodney soils are Humo-Ferric Podzols, but some just meet the requirements for Ferro-Humic Podzols, of which this is an example. The thin fragipan at this site is an intermittent feature in Rodney soils.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	2 - 0	Felty mor. Moss, twig, and needle litter and semidecomposed material, bound tightly by roots and fungal hyphae, with incipient H layer; abrupt, smooth boundary; pH 3.8.
Ae	0 - 3	Weak red (2.5YR 4/2), gravelly fine sandy loam; weak, fine subangular blocky; very friable; many, fine, tubular and interstitial pores; abundant roots; 40% subangular stones of all sizes; horizon 2–6 inches thick; clear, smooth boundary; pH 4.1.
Bfh	3 - 13	Yellowish red (5YR 4/7) gravelly fine sandy loam; strong, fine granular; friable and rather fluffy; many, very fine, interstitial pores; abundant roots; 15% subangular stones and cobbles; clear wavy boundary; pH 4.8.
Bm	13 - 23	Reddish brown (2.5YR 4/4) fine sandy loam; weak, coarse platy and moderate, fine subangular blocky; common, very fine, tubular and vesicular pores; few roots; 25% subangular sandstone and crystalline cobbles; gradual boundary; pH 4.9.
Bx	23 - 30	Reddish brown (5YR 4/3) fine sandy loam; moderate, coarse platy; common, very fine, vesicular pores and planar voids; very few roots; 20% sandstone and crystalline stones and cobbles, with rounded conglomerate gravel; gradual boundary; pH 5.0.
C	30+	Reddish brown (5YR 4/3) gravelly sandy loam; weak, coarse pseudoplaty; common, very fine, interstitial pores; no roots; 20% sandstone and crystalline stones, with weathered conglomerates; pH 5.0.

ROSSWAY SERIES — *4.22 Mini Ferro-Humic Podzol*

SITE DESCRIPTION

Location	1 mile S of East Advocate.
Parent material	Reddish brown cobbly till of sandy loam texture, derived mainly from Triassic basalt, with some admixture of sandstones; thinly covers basalt bedrock.
Drainage	Internal: good. Site: rapid.
Topography	7% convex N slope with slightly hummocky and very stony surface; elevation 400 ft.
Vegetation and land use	Mature forest of red spruce and balsam fir. Agricultural capability 7P.
Note	The parent material at this site is somewhat redder than that in Rossway soils elsewhere in the province. The Spencer Series, to which this soil formerly belonged, has been discontinued.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	2 - 0	Mull-like moder. Very thin L and F layer over well-decomposed granular humus containing mineral grains; abrupt, wavy boundary; pH 4.1.
Ahe	0 - 1	Dark grayish brown (10YR 4/2) sandy loam; moderate, very fine granular; friable; abrupt, wavy boundary; pH 4.4.
Bhf	1 - 8	Yellowish brown (10YR 5/6) sandy loam; moderate, fine subangular blocky; friable; 20% angular basalt cobble and subangular gravel; clear, smooth boundary; pH 5.0.
Bfh	8 - 15	Reddish brown (5YR 5/4) sandy loam; moderate, fine subangular blocky; friable; 20% angular basalt cobble and gravel; clear, smooth boundary; pH 5.4.
Bf	15 - 22	Reddish brown (2.5YR 4/4) sandy loam; weak, medium subangular blocky and coarse platy; firm; 25% angular basalt cobbles; some sandstone; gradual, smooth boundary; pH 5.7.
C	22 - 33+	Reddish brown (2.5YR 4/4) sandy loam; amorphous; friable; 35% basalt cobbles and stones.

SHULIE SERIES — *4.31 Orthic Humo-Ferric Podzol*

SITE DESCRIPTION

Location	0.5 mile S of Little Forks.
Parent material	Reddish brown compact sandy loam till derived from Carboniferous gray and red hard sandstones.
Drainage	Internal: good. Site: moderately rapid.
Topography	2% N slope with very stony surface; elevation 100 ft.
Vegetation and land use	Second-growth forest of maples and birches, with some poplar; moderate understory of ferns. Agricultural capability 7P.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	2 - 0	Mor; dark brown, semidecomposed, coniferous and deciduous litter, with no H layer; abrupt, wavy boundary.
Ae	0 - 3	Light brownish gray (10YR 6/2) sandy loam; single grain; loose; many, very fine pores; few roots; abrupt, wavy boundary; pH 3.8.
Bfh	3 - 11	Strong brown (7.5YR 5/8) sandy loam; moderate, fine granular; friable; many, very fine, interstitial pores; plentiful roots; gradual, smooth boundary; pH 4.3.
Bf	11 - 18	Brown (7.5YR 4/4) sandy loam; moderate, fine subangular blocky; friable; common, fine pores; plentiful roots; gradual, smooth boundary; pH 4.8.
C	18 - 24+	Reddish brown (5YR 4/4) sandy loam; weak, pseudoblocky; friable to firm and quite compact; few, fine pores; 25% subangular sandstone cobble and gravel; pH 5.0.

SPRINGHILL SERIES — *5.42/8 Gleyed Degraded Dystric Brunisol*

SITE DESCRIPTION

Location	3.5 miles N of River Hebert on W side of road to Minudie.
Parent material	Brown compact sandy loam till derived from Carboniferous gray sandstones and some red sandstone.
Drainage	Internal: imperfect. Site: moderate.
Topography	2% slightly convex SE slope with gentle hummocks and moderately stony surface; elevation 90 ft.
Vegetation and land use	Low open forest of red and black spruce with a few larch; dense understory of sheep-laurel, leatherleaf, witherod, and rhodora. Agricultural capability 3d.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	4 - 0	Moder. 2 inches of fairly well decomposed fibrous F material over a somewhat greasy, discontinuous H horizon; abrupt, smooth boundary.
Ae	0 - 3	Light gray (5Y 7/2m, 8/1d) fine sandy loam, with some irregular light brownish gray (10YR 6/2m) patches of organic staining; few, fine, distinct, yellow mottles at base of horizon; weak, fine platy and single grain; very friable to loose; many, micro, interstitial pores; plentiful, fine roots; 10% subangular sandstone pebbles and cobbles; clear, wavy boundary; pH 4.6.
Aeg	3 - 7	Dark grayish brown (10YR 4/2m, 6/3d) and grayish brown (10YR 5/2m; 7/2d) fine sandy loam; common, fine, prominent, yellow (10YR 7/6m) mottles; weak, medium subangular blocky and single grain; friable; many, very fine, interstitial pores; plentiful roots; 15% subangular sandstone pebbles and cobbles; clear, wavy boundary; pH 4.6.
Bhfg	7 - 8	Reddish brown (5YR 3.5/3m) gravelly sandy loam; common, fine, distinct, strong brown (7.5YR 5/6m) mottles (rubbed dry 7.5YR 6/4); moderate, fine granular and single grain; friable; many, very fine, interstitial pores; abundant, fine and medium roots; black organic coatings on mineral grains; horizon discontinuous; abrupt, smooth boundary.
Bmg	8 - 10	Strong brown (7.5YR 5/6m) fine sandy loam; common, fine, faint, yellowish mottles (7.5YR 6/4 dry rubbed); moderate, medium subangular blocky; very friable; common, fine, interstitial pores; few roots; 20% rounded and subangular sandstone pebbles; some ped faces colored as underlying horizon; clear boundary; pH 4.6.
Bx	10 - 26	Reddish brown (5YR 4/4m, 6/4d) fine sandy loam; moderate, coarse platy with grayish vertical fracture planes every 18 to 24 inches; firm and compact; many, very fine, vesicular and interstitial pores; very few roots; 20% subangular and angular sandstone pebbles, cobbles, and stones; gradual boundary; pH 5.0.

C	26 - 40+	Brown (7.5YR 4.5/4m, 6/4d) gravelly fine sandy loam; amorphous; firm and compact; common, very fine pores; 50% large subangular and rounded sandstone pebbles and cobbles, some manganiferous; some evidence of water-working; pH 4.6.

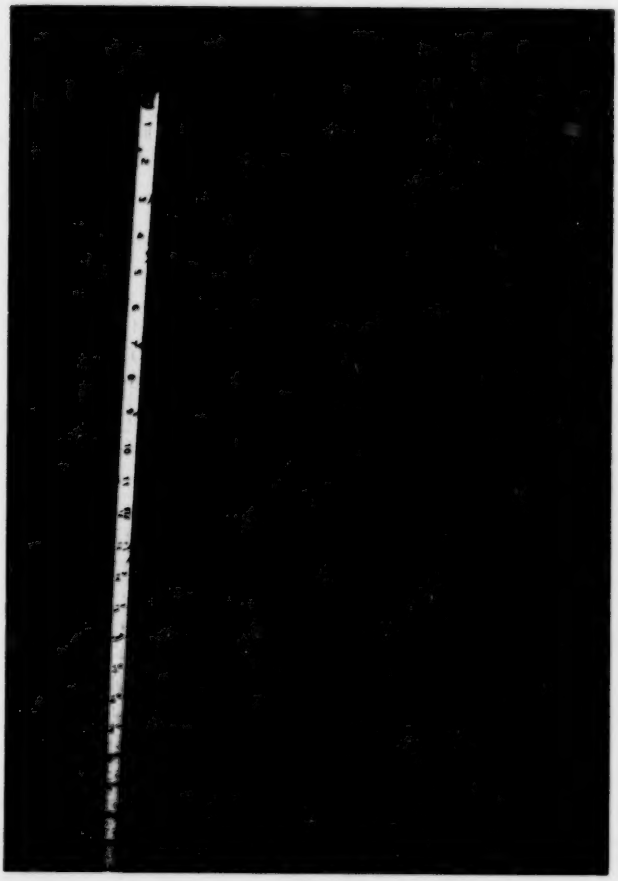

Fig. 18. Orthic Ferro-Humic Podzol, Cobequid sandy loam.

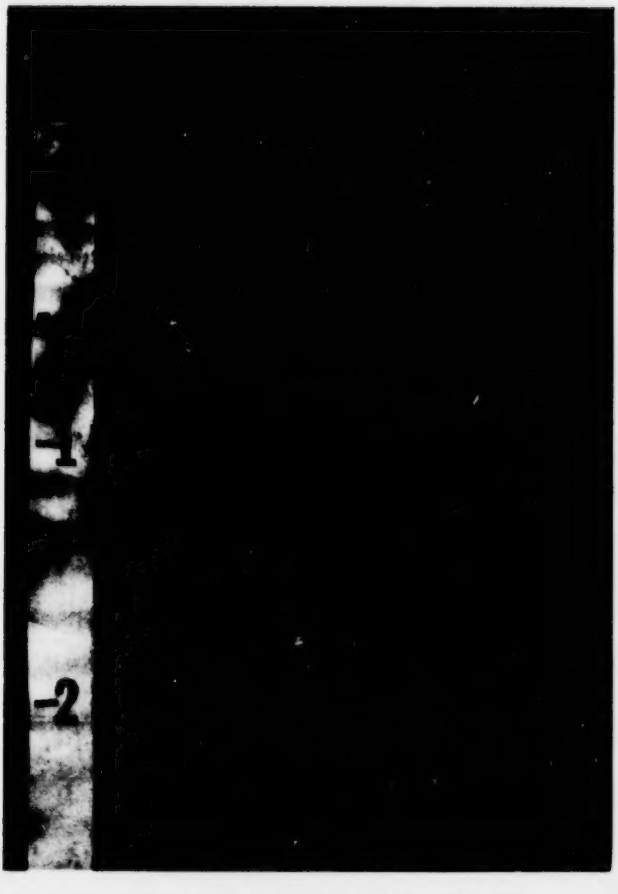

Fig. 19. Gleyed Degraded Dystric Brunisol, Debert sandy loam.

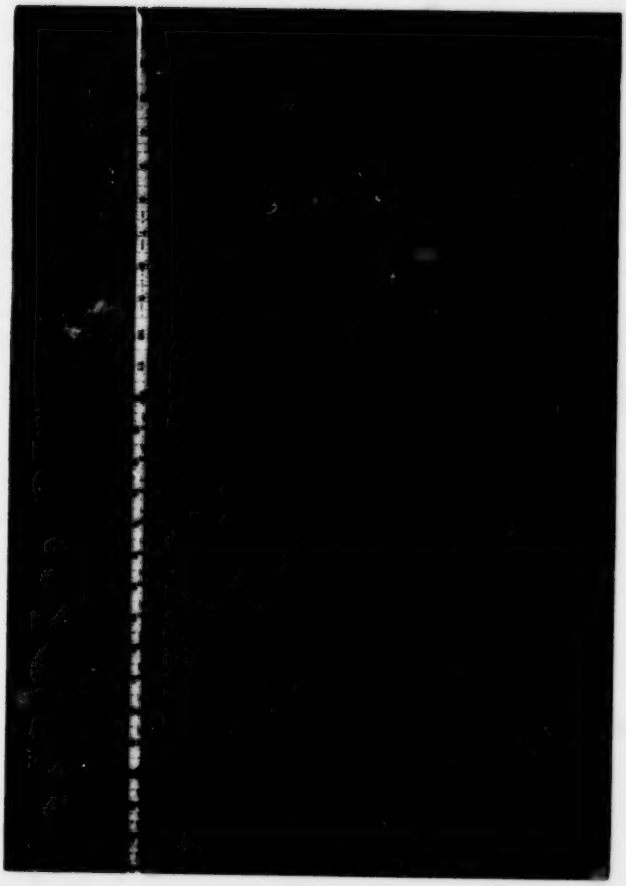

Fig. 20. Orthic Gleysol with fragipan, Masstown sandy loam.

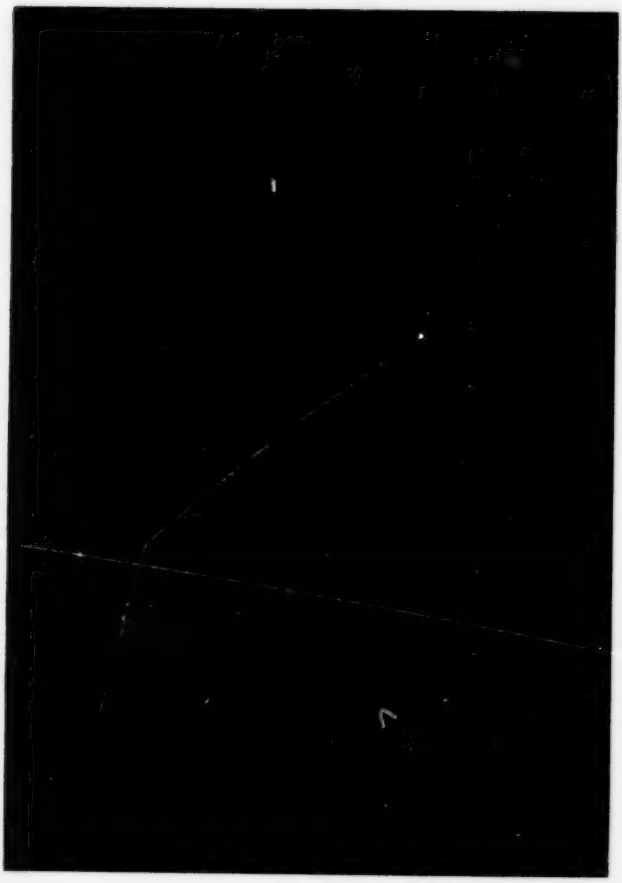

Fig. 21. Low Humic Eluviated Gleysol, Kingsville sandy clay loam.

Fig. 22. Orthic Humo-Ferric Podzol, Tormentine sandy loam.

TORMENTINE SERIES — *4.31 Orthic Humo-Ferric Podzol*

SITE DESCRIPTION

Location	1 mile SE of Rockwell Settlement.
Parent material	Red to reddish brown compact sandy loam till derived from Permo-Carboniferous soft red micaceous sandstones, weakly calcareous.
Drainage	Internal: moderately good. Site: moderately rapid.
Topography	4% even SE slope with a hummocky stoneless surface; elevation 40 ft.
Vegetation and land use	Mature forest of red spruce, with a few maple and birch. Agricultural capability 2FC.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	4 - 0	L: 3 inches of needles; F: 0.5 to 1 inch of felty mor; H: less than 0.5 inch and discontinuous layer of granular mor; abrupt, smooth boundary; pH 3.6.
Ae	0 - 4	Light reddish brown (5YR 6/3m, 5YR 7/3d) very fine sandy loam; weak, fine platy, crushes readily to fine granular and single grain; friable; many, micro, interstitial pores; abrupt, irregular boundary; pH 3.9.
Bfh	4 - 12	Yellowish red (5YR 4/6m, 5YR 5/4d) very fine sandy loam; fine granular; many, micro and fine, interstitial pores; clear, wavy boundary; pH 4.7.
Bxj	12 - 22	Yellowish red (5YR 5/6m, 5YR 5/4d) very fine sandy loam; moderate, medium platy; firm to friable; common, very fine, vesicular pores; few, thin clay films; 15% angular, reddish brown sandstone cobbles, clear, smooth boundary; pH 6.0.
C	22 - 48	Reddish brown to red (2.5YR 4/4 - 4/6) very fine sandy loam to loam; weak, coarse platy to fine blocky; firm to friable; few, very fine, vesicular pores; few, very thin clay films; 10% angular sandstone cobbles; weakly calcareous; pH (24 - 37 inches) 6.8, (37 - 48 inches) 7.1.

WESTBROOK SERIES — *4.31 Orthic Humo-Ferric Podzol*

SITE DESCRIPTION

Location	1.5 miles E of Lower Greenville.
Parent material	Reddish brown sandy loam till derived from Carboniferous conglomerate.
Drainage	Internal: good. Site: rapid and shedding.
Topography	5% even N slope with very rough hummocky surface; very stony; elevation 250 ft.
Vegetation and land use	Good-quality forest of red spruce and balsam fir, with open canopy, recently thinned; dense understory of ferns and tree seedlings. Agricultural capability 7P.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	5 - 0	Raw moder. 1 inch of L over 3–4 inches of felty F layer, containing many droppings; incipient discontinous Hi layer merges into F; abrupt, wavy boundary; pH 4.5.
Ae	0 - 3	Reddish brown (5YR 5/3m, 6/2d) sandy loam; single grain; loose; many, very fine pores; plentiful roots; 1–7 inches thick; clear irregular boundary; pH 3.9.
Bfh	3 - 13	Red (2.5YR 4/6m, 5/5d) fine sandy loam; weak, fine subangular blocky and fine granular; friable, many, fine pores; abundant roots; gradual, wavy boundary; pH 5.2.
Bf	13 - 24	Reddish brown (2.5YR 3.5/4m, 5/4d) gravelly sandy loam; weak, fine subangular blocky; friable to loose; many, very fine pores; 25% rounded pebbles; gradual, smooth boundary.
C	24 - 44+	Reddish brown (2.5YR 4/4m, 5/4d) loam to sandy loam; weak, subangular pseudoblocky; loose but with compact packing; many, fine pores, 40% rounded pebbles and weathered conglomerate stones and cobbles; pH (24–36 inches) 5.1, (36–44 inches) 5.1.

WYVERN SERIES — *4.21 Orthic Ferro-Humic Podzol*

SITE DESCRIPTION

Location	2 miles S of Westchester Station.
Parent material	Brown gravelly sandy loam till derived from granite.
Drainage	Internal: good. Site: rapid and shedding.
Topography	5% to 7% broken NW slope with a very hummocky surface; very stony; elevation 750 ft.
Vegetation and land use	Medium-aged forest of red spruce, red maple, and beech, with a few balsam fir and birches; open floor. Agricultural capability 7P.

PROFILE DESCRIPTION

Horizon	*Depth inches*	
LFH	2.5 - 0	Moder. 1 inch of mixed broad-leaved and needle litter, 1.5 inches of mixed F and Hi material, with conspicuous washed sand grains; abrupt, wavy boundary; pH 4.1.
Ae	0 - 1.5	Brown (7.5YR 5/2) fine sandy loam; weak, fine subangular blocky; very friable; many, micro, interstitial pores; abundant, fine and medium roots; abrupt, irregular boundary; pH 3.9.
Bhf	1.5 - 10	Brown to dark brown (7.5YR 4/4) gravelly fine sandy loam; moderate, fine crumblike subangular blocky; friable, soft; many, very fine, interstitial pores; abundant, fine and medium roots, abrupt smooth boundary; pH 4.6.
Bfh + Bf	10 - 20	Brown to strong brown (7.5YR 5/5) fine sandy loam; moderate, fine subangular blocky; friable; more compact than horizon above; many, fine, interstitial pores; plentiful roots; 20% subangular crystalline stones and gravel; clear, smooth boundary; pH 4.9.
BC	20 - 27	Brown (7.5YR 5/4) fine sandy loam; coarse platy; firm, hard; weakly cemented; many, very fine, interstitial and vesicular pores; 60–70% by volume of strongly weathered crystalline rock fragments; clear, smooth boundary; pH 5.0.
C	27 - 36+	Brown (10YR 5/3) gravelly coarse sandy loam to loamy coarse sand; loose, many, fine, interstitial pores; 80% weathered fragmented crystalline rocks of all sizes; pH 5.0.

Analysis of Soil Samples

Chemical and physical data for most of the soils described in the foregoing section are tabulated under "General Analytical Data" in Appendix 2. The laboratory procedures are outlined below.

pH was determined electrometrically on a 1:1 soil–liquid slurry, using water and calcium chloride (0.01 M $CaCl_2$).

Loss on ignition was determined by heating the soil to 450 C.

Iron and aluminum were determined by the oxalate and dithionite extraction procedures of McKeague and Day (Can. J. Soil Sci. 1966. 46:13-22).

Exchangeable cations were determined by the following methods. (i) After extraction in ammonium acetate (NH_4OAc) Ca and K were determined with the flame emission spectrophotometer and Mg by atomic absorption. The total exchange acidity and exchangeable Al were determined in KCl extracts by NaOH and HCl titrations, and exchangeable H was obtained by difference. (ii) Permanent charge exchange capacity is the sum of exchangeable Ca, Mg, and Al displaced by NaCl, by the method of Clark et al. (Can. J. Soil Sci. 1966. 46:161-166). The base saturation is Ca + Mg/CEC, as determined by this method.

Particle size analysis was done by the method of Kilmer and Alexander (Soil Sci. 1949. 68:15-24) with modifications suggested by Toogood and Peters (Can. J. Agr. Sci. 1953. 33:159-171). Clay was determined by pipette, the sand fractions by dry sieving, and the silt by difference. The particle size analysis for engineering purposes was done by standard procedures and is discussed in the section "Civil Engineering Aspects." The data, which are derived from a different set of soil samples, are tabulated separately under "Engineering Data" in Appendix 2.

Determinations of pore space, hydraulic conductivity, bulk density, and shrinkage, performed only on the Tormentine and Debert soils, were based on the procedures of Uhland and O'Neal (USDA-SCS Tech. Publ. 101, 1951) with modifications. Triplicate "undisturbed" soil cores were used. Hydraulic conductivity was determined on saturated cores.

Organic carbon was determined by wet combustion for the Queens and dry combustion for the Joggins soils. Total Fe, Ti, and Mn for the Joggins soils were determined by the methods of Shapiro and Brannock (Bull. 1036-C U.S. Geol. Survey, 1956), except that Mn was determined by atomic absorption.

Some of the analytical information was referred to under "Description of the Soils." Further comments on its significance are given below.

Soil Acidity

The soil reaction, acid or alkaline, is expressed in pH units and the optimum for cultivated soils when determined in water is 5.6–7.5 (medium acid to mildly alkaline). Almost all the undisturbed surface soils in Cumberland County have a pH value less than 5 (very strongly acid) or 4.5 (extremely acid) and therefore require heavy applications of lime at frequent intervals. Some Acadia soils have a surface pH of more than 5, and coastal salt marsh is alkaline.

The pH rises with depth, insignificantly in many sandy and gravelly soils, but markedly in finer-textured soils and those developed from materials that contain natural lime. Neutral reaction is found at a depth of 3 to 4 ft in many Hansford, Pugwash, Tormentine, Debert, Masstown, Falmouth, Queens, Diligence, Joggins, Kingsville, and Acadia soils. Cumberland, Bridgeville, and Chaswood soils of stream floodplains are generally less acid than the upland soils.

The pH measured in $CaCl_2$ is a more stable value that is independent of free salts in the soil and varies little with dilution of the sample. It correlates well with the degree of base saturation in the soil; when the pH is less than 4.6 the cation exchange sites are unsaturated and hold Al and H. The pH ($CaCl_2$) is usually 0.5 unit lower than the pH (H_2O).

Loss on Ignition and Organic Matter

The loss of volatile material when soil is heated in a furnace is a rough indication of its organic matter content. The surface LFH layers of undisturbed soils in forest are dominantly organic and represent a balance between the annual rate of replenishment of litter and its decomposition. When the land is cleared and plowed, the supply of organic matter is reduced, decomposition is rapid, and organic matter levels of from 4% to 6% are established in the surface layer. Effective bonding of mineral soil particles into durable aggregates requires the highest possible levels of organic matter, in combination with lime to raise the pH and stimulate biological activity.

Organic material in solution and suspension penetrates the soil profile and its accumulation in association with Fe produces the friable, porous, B horizon of podzol soils. Moderate amounts may occur in the profiles of the stream floodplain soils, Cumberland, Bridgeville, and Chaswood, but the remaining soils have very low levels of organic matter below the surface layer. Poorly drained mineral soils have higher levels of organic matter in surface layers than well-drained soils due to the restricted decomposition under wet conditions, but these also have low levels in the subsurface layers.

Organic matter is a major source of N and provides many other plant nutrients. Its valuable nutritional function can be replaced by artificial fertilizers, but not its physical benefits such as good soil structure and resistance to erosion.

Iron and Aluminum

Amorphous or mobilized forms of Fe and Al in combination with organic matter improve the structure of soil and raise its cation-exchange capacity. The distribution of amorphous Fe and Al in a soil profile assists in interpreting the soil processes that produced the soil and in differentiating certain classes of soil.

The total content of Fe and Al varies with the type of soil parent material. A proportion of these elements is leached through the soil in solution and may be deposited in the B horizon as amorphous oxides in association with organic matter. The oxalate extracts referred to in the data tables include for the most part only amorphous oxides. The dithionite extracts include in addition the crystalline oxides in unweathered soil material. (In some gleysolic soils they may include mobile oxides that have recrystallized.)

Podzol soils must have a 4-inch B horizon in which the percentage oxalate-extractable Fe and Al exceeds that of the C horizon by 0.8 or more. The data show that in some podzol soils in Cumberland County, e.g., Pugwash and Tormentine, the development of podzolic B horizons is not particularly strong; this is partly due to the density of the subsoil, which restricts leaching. All the imperfectly and poorly drained soils have low levels of amorphous oxides in the B horizon; the Fe and Al removed from the A horizon have failed to accumulate and may have been removed in lateral seepage water. The data for the Debert and Springhill soils, which

resemble podzols, show why such soils cannot be classified as such. The highest contents of amorphous iron and aluminum oxides are in the Cobequid and Kirkhill soils, which have high total Fe and Al derived from the ferromagnesian minerals in their parent material.

Exchangeable Cations and Exchange Capacity

The capacity of the soil to hold exchangeable cations is indicative of the nutrients available for plant growth and the expected response of the soil to fertilizer applications. Organic matter, clay particles, and colloids are able to retain elements such as H, Al, Ca, Mg, K, and Na on their surfaces in the form of ions. Cations are readily available to plants and can be displaced by other cations. When the pH (in H_2O) is over 5 or 5.5 the H and Al can be replaced by useful nutrient cations. At lower pH values H and Al dominate the exchange complex.

The soils analyzed have a low cation-exchange capacity of between 2 and 12 meq/100 g in their mineral horizons. Lowest values are in the coarse-textured soils and highest in the finer-textured ones and in the Bhf and Bfh horizons of podzols.

The exchangeable K is very low in all the soils, being less than 0.2 meq/100 g in all but the Acadia soils. Ca and Mg were very low in all but the Acadia and lower horizons of some profiles developed on materials containing natural limestone. The apparent high exchange capacity values for LFH layers should be considered in the light of their very low bulk density.

The permanent charge exchange capacity is a more realistic measure of the effective exchange capacity and actual base saturation than the exchangeables determined on neutral ammonium acetate extracts, which include the pH-dependent charge.

Physical Composition

Soil texture, the proportions of sand, silt, and clay particles, was determined by mechanical analysis using the pipette method. The textural classes, such as sandy loam and clay loam, are shown in Figure 23, and there is further information on texture in Appendix I. This and other physical features of the soil are given in the detailed profile descriptions earlier in this section.

The aspects of the physical composition of the soil that are of specific interest to engineers are discussed in the section "Civil Engineering Aspects," and supporting data are bound together with the general analytical data in Appendix II.

Table 25. Acreages of the soil series and phases, and percentages of the total land area

Phase	Acreage	% of total land area
	Acadia Soil Complex (Ac)	
Ac. A - 0	7,858	
Ac - b. A - 0	4,601	
Ac - w. A - 0	1,123	
Ac - w. B - 0	641	
Total	14,223	1.4
	Bridgeville Series (Bv)	
A - 0	132	
B - 0	191	
B - 2	179	
C - 0	116	
C - 2	240	
Total	858	0.1
	Chaswood Series (Ch)	
A - 0	247	
B - 0	4,083	
B - 1	1,351	
B - 2	187	
C - 1	776	
C - 2	231	
Total	6,875	0.7
	Cobequid Series (Cd)	
B - 3	179	
C - 3	128	
D - 2	207	
D - 3	9,597	
D/E - 3	49,644	
E - 3	10,036	
E/F - 3	4,978	
F - 3	5,995	
G - 3	3,459	
Total	84,223	8.1
	Cumberland Series (C)	
A - 0	414	
B - 0	2,877	
B - 1	2,351	
C - 0	1,056	
C - 1	1,332	
C - 2	108	
C - 3	136	
Total	8,274	0.8

Table 25. Acreages of soil series and phases, and percentages of the total land area (cont'd)

Phase	Acreage	% of total land area
	Debert Series (De)	
B - 0	574	
B - 1	15,584	
B - 2	741	
B - 3	590	
C - 0	15,910	
C - 1	46,910	
C - 2	35,392	
C - 3	4,859	
C/D - 2	9,952	
D - 0	881	
D - 1	1,132	
D - 2	2,363	
D - 3	8,545	
Total	143,433	13.8
	Diligence Series (D)	
C - 1	558	
C - 2	571	
D - 1	195	
D - 2	2,244	
D - 3	5,716	
E - 2	1,383	
E - 3	2,300	
Total	12,967	1.2
	Economy Series (Ec)	
B - 2	311	
B - 3	4,993	
C - 3	17,542	
D - 3	918	
Total	23,764	2.3
	Falmouth Series (F)	
C - 1	1,212	
C - 2	1,255	
D - 1	2,308	
Total	4,775	0.5
	Hunsford Series (Hd)	
C - 1	1,192	
C - 2	3,567	
C - 3	5,177	
D - 2	3,069	
D - 3	6,070	
Total	19,075	1.8

Table 25. Acreages of soil series and phases, and percentages of the total land area (cont'd)

Phase	Acreage	% of total land area
	Hebert Series (H)	
B - 0	207	
B - 1	4,396	
B - 2	179	
B - 3	128	
B/C - 1	343	
C - 0	1,794	
C - 1	6,440	
C - 2	3,585	
C - 3	136	
D - 1	6,401	
D - 2	884	
D - 3	160	
D/E - 3	387	
E - 1	916	
E - 2	1,686	
E - 3	144	
F - 2	151	
Total	27,937	2.7
	Joggins Series (J)	
B - 1	805	
C - 1	534	
C - 2	7,879	
C - 3	1,248	
D - 2	1,180	
Total	11,646	1.1
	Kingsville Series (Kv)	
B - 1	2,252	
B - 2	1,096	
C - 0	116	
C - 1	4,328	
C - 2	1,626	
C - 3	805	
Total	10,223	1.0
	Kirkhill Series (K)	
C - 1	124	
C - 2	279	
D - 1	4,950	
D - 2	2,913	
D - 3	4,746	
E - 1	112	
E - 2	13,387	
E - 3	4,248	
E/F - 1	97	
E/F - 2	10,891	
F - 2	1,578	
F/G - 2	1,343	
G - 2	1,598	
G - 3	761	
Total	47,027	4.5

Table 25. Acreages of soil series and phases, and percentages of the total land area (cont'd)

Phase	Acreage	% of total land area
	Masstown Series (Ma)	
A - 0	120	
B - 0	34,077	
B - 1	10,518	
B - 2	949	
B - 3	558	
B/C - 0	1,451	
C - 0	1,782	
C - 1	5,699	
C - 2	6,190	
C - 3	1,379	
Total	62,723	6.0
	Millar Series (Mr)	
B - 0	487	
B - 1	1,041	
B - 3	120	
C - 1	326	
C - 2	104	
Total	2,078	0.2
	Pugwash Series (Pu)	
B - 1	116	
B - 2	379	
C - 0	721	
C - 1	14,591	
C - 2	8,002	
C - 3	8,628	
D - 0	219	
D - 1	6,843	
D - 2	4,013	
D - 3	3,875	
E - 2	128	
Total	47,515	4.6
	Queens Series (Q)	
B - 1	1,949	
B - 2	1,319	
C - 0	530	
C - 1	36,141	
C - 2	21,634	
C - 3	1,881	
C/D - 0	379	
D - 0	311	
D - 1	6,680	
D - 2	4,312	
D - 3	155	
E - 2	211	
F - 2	92	
F - 3	108	
Total	75,702	7.3

Table 25. Acreages of soil series and phases, and percentages of the total land area (cont'd)

Phase	Acreage	% of total land area
	Rodney Series (Ro)	
C - 3	17,095	
D - 1	630	
D - 2	2,259	
D - 3	51,621	
E - 1	326	
E - 2	2,790	
E - 3	8,521	
F - 3	1,957	
Total	85,199	8.2
	Rossway Series (Ry)	
D - 2	207	
D - 3	486	
E/F - 3	1,522	
F - 3	163	
Total	2,378	0.2
	Shulie Series (S)	
C - 2	1,188	
C - 3	52,379	
D - 1	124	
D - 2	311	
D - 3	51,159	
D/E - 3	2,096	
E - 3	104	
F - 3	446	
Total	107,807	10.4
	Springhill Series (Sl)	
B - 3	271	
C - 2	1,109	
C - 3	24,571	
D - 3	9,845	
Total	35,796	3.4
	Tormentine Series (T)	
B - 1	725	
B - 2	387	
C - 0	9,804	
C - 1	5,795	
C - 2	403	
D - 0	6,640	
D - 1	2,209	
E - 0	295	
E - 1	327	
F - 0	143	
Total	26,728	2.5

Table 25. Acreages of soil series and phases, and percentages of the total land area (cont'd)

Phase	Acreage	% of total land area
	Westbrook Series (W)	
C - 2	2,396	
C - 3	6,114	
D - 1	1,032	
D - 2	16,535	
D - 3	24,895	
D/E - 3	26,416	
E - 1	236	
E - 2	893	
E - 3	5,238	
E/G - 3	4,776	
F - 3	7,122	
G - 3	1,474	
Total	97,127	9.3
	Wyvern Series (Wn)	
D - 1	240	
D - 2	2,072	
D - 3	22,415	
D/E - 2	1,586	
D/E - 3	12,323	
E - 2	104	
E - 3	3,499	
F - 3	8,071	
F/G - 3	2,439	
G - 3	454	
Total	53,203	5.1
	Rocky Land (R)	
	9,020	0.9
	Coastal Beach (Cb)	
	311	-
	Salt Marsh (S.M.)	
	5,146	0.5
	Peat (P)	
	14,786	1.4
	Total Land Area	
	1,040,819	100.0
	Inland Water	
	12,718	
	Total Area	
	1,053,537	

GLOSSARY

acidity See **pH, soil.**

alluvium Material such as clay, silt, sand, and gravel deposited by modern rivers and streams.

association, soil In Canada this term has the same meaning as catena. In the United States it has two meanings. (i) A group of defined and named taxonomic soil units occurring together in an individual and characteristic pattern over a geographic region, comparable to plant associations in many ways. It is sometimes called natural land types. (ii) A mapping unit used on general soil maps in which two or more defined units occurring together in a characteristic pattern are combined because the scale of the map, or the purpose for which it is being made, does not require delineation of the individual soils.

boulders Rock fragments over 60 cm (2 ft) in diameter.

bulk density, soil The mass of dry soil per unit bulk volume. The bulk volume is determined before the soil is dried to constant weight at 105 C. It is also called apparent density.

calcareous soil Soil containing sufficient calcium carbonate, often with magnesium carbonate, to effervesce visibly when treated with cold 0.1 N hydrochloric acid.

catena A sequence of soils of about the same age, derived from similar parent materials, and occurring under similar climatic conditions, but having unlike characteristics because of variations in relief and in drainage.

cation-exchange capacity The total amount of exchangeable cations that a soil can adsorb. It is sometimes called "total-exchange capacity," "base-exchange capacity," or "cation-adsorption capacity." It is expressed in milliequivalents per 100 g of soil or of other adsorbing material such as clay. See also **effective cation-exchange capacity** and **pH-dependent cation-exchange capacity.**

chroma The relative purity, strength, or saturation of a color. It is directly related to the dominance of the determining wavelength of light and inversely related to grayness. It is one of the three variables of color. See also **Munsell color system; hue;** and **value, color.**

cobble See **cobblestone.**

cobblestone Rounded or partially rounded rock or mineral fragments 7.5 to 25 cm (3 to 10 inches) in diameter. See also **coarse fragments.**

complex, soil A mapping unit used in detailed and reconnaissance soil surveys where two or more defined soil units are so intimately intermixed geographically that it is impractical, because of the scale used, to separate them.

consistence, soil (i) The resistance of a material to deformation or rupture. (ii) The degree of cohesion or adhesion of the soil mass. Terms used for describing consistence at various soil moisture contents are:

wet soil—nonsticky; slightly sticky, sticky, and very sticky; nonplastic, slightly plastic, plastic, and very plastic.

moist soil—loose, very friable, friable, firm, and very firm; compact, very compact, and extremely compact.

dry soil—loose, soft, slightly hard, hard, very hard, and extremely hard.

cementation—weakly cemented, strongly cemented, and indurated.

Dystric Brunisol A great group of soils in the Brunisolic Order. The soils may have mull Ah horizons less than 5 cm (2 inches) thick. They have Bm horizons in which the base saturation (NaCl) is usually 65% to 100% and the pH ($CaCl_2$) is usually 5.5 or lower.

Eluviated Gleysol A great group of soils in the Gleysolic Order developed under wet conditions, under grass or forest or both. The soils have Aeg and Btg horizons.

esker A winding ridge of irregularly stratified sand, gravel, and cobbles deposited under the ice by a rapidly flowing glacial stream.

evapotranspiration The loss of water from a given area during a specified time by evaporation from the soil surface and by transpiration from the plants. Potential evapotranspiration is the maximum transpiration that can occur in a given weather situation with a low-growing crop that is not short of water and does not completely shade the ground.

family, soil The third category (III) in the Canadian system of soil classification. Differentiae are

primarily texture, drainage, thickness of horizons, permeability, mineralogy, consistence, and reaction.

Ferro-Humic Podzol A great group of soils in the Podzolic Order. The upper 10 cm (4 inches) of the B horizon (Bhf) contains more than 10% organic matter and enough oxalate-extractable Al and Fe to satisfy the requirements of a Bf horizon. The ratio of organic matter to oxalate-extractable Fe in the B horizon is less than 20. The B horizon is usually overlain by a light-colored, illuviated horizon (Ae) and a mor humus layer.

fine earth The fraction of mineral soil consisting of particles less than 2 mm in diameter.

fine texture Consisting of or containing large quantities of the fine fractions, particularly of silt and clay. It includes all the textural classes of clay loams and clays: clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, and clay. Sometimes it is subdivided into clayey texture and moderately fine texture. See also **texture, soil.**

fragipan A natural subsurface horizon having a higher bulk density than the solum above; seemingly cemented when dry, but showing moderate to weak brittleness when moist. The layer is low in organic matter, mottled, slowly or very slowly permeable to water, and usually has some polygon-shaped bleached cracks. It is found in profiles of either cultivated or virgin soils but not in calcareous material.

glacial till Unsorted and unstratified materials deposited by glacial ice.

glaciofluvial deposits Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces. See also **glacial drift** and **glacial till.**

gleysation A soil-forming process, operating under poor drainage conditions, which results in the reduction of iron and other elements and in gray colors, and mottles. See also **Gleysolic** and **Gleysol.**

Gleysol A great group of soils in the Gleysolic Order. A thin (less than 7.6 cm, or 3 inches) Ah horizon is underlain by mottled gray or brownish gleyed material, or the soil has no Ah horizon. Up to 30.5 cm (12 inches) of consolidated peat or 45.7 cm (18 inches) of unconsolidated peat may occur on the surface.

gravel Rock fragments 2 mm to 7.6 cm (3 inches) in diameter.

Gray Luvisol A great group of soils in the Luvisolic Order occurring in moderately cool climates, where the mean annual temperature is usually lower than 42 F. The soils have developed under deciduous and coniferous forest cover, and have an eluviated light-colored surface (Ae) horizon, a brownish illuvial B (Bt) horizon, and usually a calcareous C horizon. The solum is base saturated (NaCl extraction). The Ah horizon, if present, is less than 5 cm (2 inches) thick.

great group The fifth category (V) in the Canadian system of soil classification. It is a taxonomic group of soils having certain morphological features in common and a similar pedogenic environment. Examples are Gray Luvisol, Humo-Ferric Podzol, Dystric Brunisol, Eluviated Gleysol, and Fibrisol.

horizon, soil A layer of soil or soil material approximately parallel to the land surface; it differs from adjacent genetically related layers in properties such as color, structure, texture, consistence, and chemical, biological, and mineralogical composition. A list of the designations used in this report and some of the properties of soil horizons and layers follows. More detailed definitions of some horizons and layers may be found in *The System of Soil Classification for Canada.*

Organic layers contain more than 30% organic matter. Two groups of these layers are recognized:

O—An organic layer developed under poorly drained conditions and often peaty.
- Of—The least decomposed organic layer, containing large amounts of well-preserved fiber, and called the fibric layer.
- Om—An intermediately decomposed organic layer containing less fiber than an Of layer and called the mesic layer.
- Oh—The most decomposed organic layer, containing only small amounts of raw fiber and called the humic layer.

L-F-H—Organic layers developed under imperfectly to well-drained conditions, often forest litter.
- L—The original structures of the organic material are easily recognized.
- F—The accumulated organic material is partly decomposed.
- H—The original structures of the organic material are unrecognizable.
- Hi—The organic matter is partially incorporated into or intermixed with the mineral soil.

Master mineral horizons and layers contain less than 30% organic matter.

A—A mineral horizon formed at or near the surface in the zone of removal of materials in solution and suspension or maximum in situ accumulation of organic matter, or both.

B—A mineral horizon characterized by one or more of the following:
1) An enrichment in silicate clay, iron, aluminum, or humus.
2) A prismatic or columnar structure that exhibits pronounced coatings or stainings associated with significant amounts of exchangeable sodium.
3) An alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both.

C—A mineral horizon comparatively unaffected by the pedogenic processes operative in A and B, except gleying, and the accumulation of carbonates and more soluble salts.

R—Underlying consolidated bedrock.

Roman numerals are prefixed to horizon designations to indicate unconsolidated lithologic discontinuities in the profile. Roman numeral I is understood for the uppermost material and therefore is not written. Subsequent contrasting materials are numbered consecutively in the order in which they are encountered downward, that is, II, III, and so on.

Lowercase Suffixes

c—A cemented (irreversible) pedogenic horizon.

e—A horizon characterized by removal of clay, iron, aluminum, or organic matter alone or in combination and higher in color value by one or more units when dry than an underlying B horizon. It is used with A (Ae).

f—A horizon enriched with hydrated iron. It usually has a chroma of 3 or more. The criteria for an f horizon except for Bgf are: the oxalate-extractable Fe + Al exceed that of the IC horizon by 0.8% or more, and the organic matter to oxalate-extractable Fe ratio is less than 20. These horizons are differentiated on the basis of organic matter content into:
Bf, less than 5% organic matter
Bfh, 5% to 10% organic matter
Bhf, greater than 10% organic matter.

g—A horizon characterized by gray colors, or prominent mottling indicative of permanent or periodic intense reduction, or both, for example, Aeg, Btg, Bg, and Cg. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

gf (used with B)—The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more and the dithionite-extractable Al does not exceed that of the IC by more than 0.5%.

h—A horizon enriched with organic matter.
Ah—An A horizon of organic matter accumulation. It contains less than 30% organic matter. It is one Munsell unit of color value darker than the layer immediately below, or it has at least 1% more organic matter than the IC, or both.
Ahe—This horizon has been degraded as evidenced by streaks and splotches of light and dark gray material and often by platy structure.
Bh—This horizon contains more than 2% organic matter, and the organic matter to oxalate-extractable Fe ratio is 20 or more.

j—This is used as a modifier of suffixes e, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies, for example, Aej is an eluvial horizon that is thin, discontinuous, or faintly discernible. Btj is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

k—Presence of carbonate.

m—A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color, or structure, or both.

p—A layer disturbed by man's activities, for example, Ap.

t—A horizon enriched with silicate clay as indicated by a higher clay content (by specified amounts) than the overlying eluvial horizon, a thickness of at least 5 cm, oriented clay in some pores, or on ped surfaces, or both, and usually a higher ratio of fine (less than 0.2 micron) to total clay than the IC horizon. Bt is a horizon that contains illuvial layer-lattice clays.

x—A horizon of fragipan character.

hue One of the three variables of color that is caused by light of certain wavelengths and changes with the wavelength. See also **Munsell color system, chroma,** and **value, color.**

Humo-Ferric Podzol A great group of soils in the Podzolic Order. The upper 10 cm (4 inches) of the B horizon (Bfh) contains less than 10% organic matter and enough oxalate-extractable Al and Fe to satisfy the requirements of a Bf horizon. The ratio of organic matter to oxalate-extractable Fe is less than 20. Most of the typical Podzols are classified as Humo-Ferric Podzols.

hydraulic conductivity The ability of the soil to transmit water, expressed as a velocity, e.g. inches per hour.

kame An irregular ridge or hill of stratified glacial drift deposited by glacial meltwater.

kettle A depression resulting from the collapse of sediments by the melting of a block of ice buried in them.

lacustrine deposit Material deposited in lake water and later exposed either by lowering of the water level or by uplifting of the land. These sediments range in texture from sands to clays.

moder A zoogenous forest humus form made up of plant remains partly disintegrated by the soil fauna (F layer), but not matted as in raw humus. It is transitional to a zone of spherical or cylindrical microejections of arthropods that is permeated by loose mineral particles in its lower part and often throughout. Although incorporation of organic matter is intense, it is shallow, because none of the organisms concerned with moder formation have important burrowing activity. The mixing of organic and mineral particles is purely mechanical. Organic matter under the F layer varies from 40% to 50%, but may exceed 60%. The C:N ratio is 20 to 25 and sometimes lower. Various subgroups can be recognized by their morphology and chemical characteristics.

mor A nonzoogenous forest humus form distinguished by a matted F layer and a holorganic H layer with a sharp delineation from the A horizon. It is generally acid, having high organic matter content (90% or more) and a high C:N ratio (25–35, sometimes higher). Various subgroups can be recognized by the morphology, and chemical and biological properties.

mull A zoogenous forest humus form consisting of an intimate mixture of well-humified organic matter and mineral soil that makes a gradual transition to the horizon underneath. It is distinguished by its crumb or granular structure, and because of the activity of the burrowing microfauna (mostly earthworms), partly decomposed organic debris does not accumulate as a distinct layer (F layer) as in mor and moder. The organic matter content is 5–20% and the C:N ration is 10–15. Various subgroups can be distinguished by the morphology and chemical characteristics.

Munsell color system A color designation system specifying the relative degrees of the three simple variables of color: hue, value, and chroma. For example: 10YR 6/4 is the color of a soil having a hue of 10YR, value of 6, and chroma of 4. These notations can be translated into several different systems of color names. See also **chroma, hue,** and **value, color.**

ortstein An indurated layer in the B horizon of Podzols in which the cementing material consists of illuviated sesquioxides and organic matter.

outwash Sediments washed out by flowing water beyond the glacier and laid down as stratified drift in thin foreset beds. The particle size may vary from boulders to silt.

parent material The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of a soil has developed by pedogenic processes.

ped A unit of soil structure such as a prism, block, or granule, which is formed by natural processes; in contrast with a clod, which is formed artificially.

pedoclimate The climate of the soil.

peneplain A rugged area that was high at one time, but has been reduced by erosion to a low, gently rolling surface resembling a plain.

periglacial Areas, conditions, processes, and deposits adjacent to the margin of a glacier.

permeability, soil (i) The ease with which gases, liquids, or plant roots penetrate or pass through a bulk mass of soil or a layer of soil. Because different soil horizons vary in permeability, the specific horizon should be designated. (ii) The property of a porous medium that relates to the ease with which gases, liquids, or other substances can pass through it.

pH, soil The negative logarithm of the hydrogen-ion activity of a soil. The degree of acidity or alkalinity of a soil as determined by means of a glass, quinhydrone, or other suitable electrode or indicator at a specified moisture content or soil–water ratio, and expressed in terms of the pH scale.

phase, soil A subdivision of a soil type or other unit of classification having characteristics that affect the use and management of the soil, but that do not vary sufficiently to differentiate it as a separate type. A variation in a property or characteristic such as degree of slope, degree of erosion, or content of stones.

profile, soil A vertical section of the soil through all its horizons and extending into the parent material.

Regosol The only great group in the Regosolic Order. The soils in the group have insufficient horizon development to meet the requirements of the other orders.

series, soil The second category (II) in the Canadian system of soil classification. This is the basic unit of soil classification, and consists of soils that are essentially alike in all major profile characteristics except the texture of the surface.

solum (plural sola) The upper horizons of a soil in which the parent material has been modified and in which most plant roots are contained. It usually consists of A and B horizons.

structure, soil The combination or arrangement of primary soil particles into secondary particles, units, or peds. These secondary units may be, but usually are not, arranged in the profile in such a manner as to give a distinctive characteristic pattern. The secondary units are characterized and classified on the basis of size, shape, and degree of distinctness into classes, types, and grades.

subgroup, soil The fourth category (IV) in the Canadian classification system. These soils are subdivisions of the great groups and therefore each soil is defined more specifically.

texture, soil The relative proportions of the various soil separates in a soil as described by the classes of soil texture shown in Fig. 23. The textural classes may be modified by adding suitable adjectives when coarse fragments are present in substantial amounts; for example, "stony silt loam," or "silt loam, stony phase." For other modifications see coarse fragments. The sand, loamy sand, and sandy loam are further subdivided on the basis of the proportions of the various sand separates present.

till See **glacial till.**

value, color The relative lightness or intensity of color and approximately a function of the square root of the total amount of light. One of the three variables of color. See also **Munsell color system, hue,** and **chroma.**

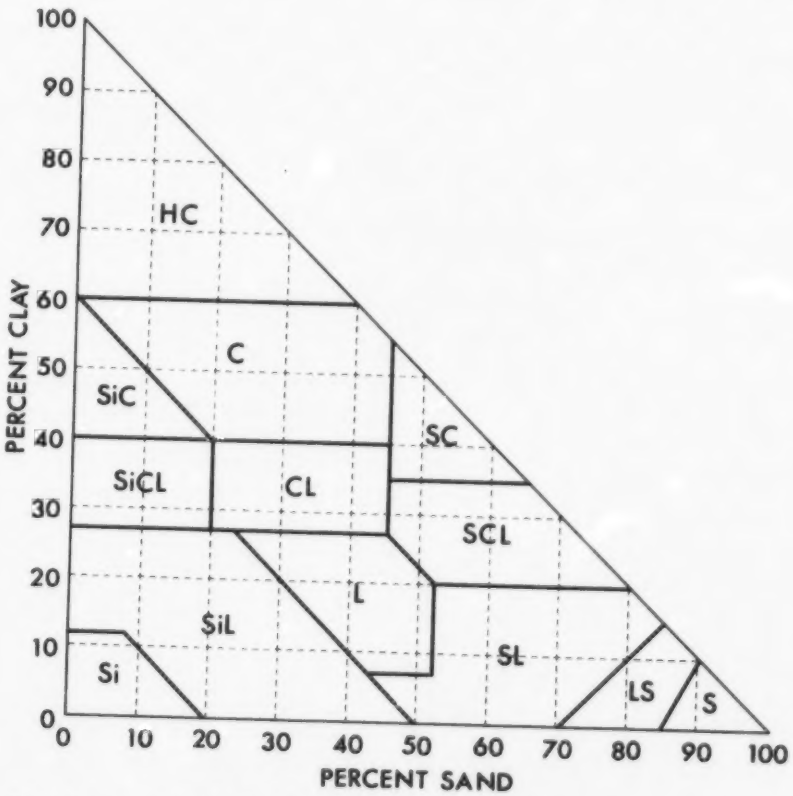

Fig. 23. Percentage of clay, silt, and sand in the main soil textural classes.

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Table 26. Common and scientific names of trees and other plants in Cumberland County

Common name	*Scientific name*
	Trees
alder, speckled	*Alnus rugosa* (Du Roi) Sprengel
ash, white	*Fraxinus americana* L.
aspen, largetooth	*Populus grandidentata* Michaux
aspen, trembling	*Populus tremuloides* Michaux
beech	*Fagus grandifolia* Ehrh.
birch, gray	*Betula populifolia* Marsh.
birch, white	*Betula papyrifera* Marsh.
birch, yellow	*Betula alleghaniensis* Britton
cherry, pin	*Prunus pensylvanica* L. f.
fir, balsam	*Abies balsamea* (L.) Miller
hemlock, eastern	*Tsuga canadensis* (L.) Carr.
maple, mountain	*Acer spicatum* Lam.
maple, red	*Acer rubrum* L.
maple, sugar	*Acer saccharum* Marsh.
mountain-ash, American	*Sorbus americana* Marsh.
oak, red	*Quercus rubra* L.
pine, eastern white	*Pinus strobus* L.
pine, jack	*Pinus banksiana* Lamb.
pine, red	*Pinus resinosa* Aiton
pine, Scots	*Pinus sylvestris* L.
poplar, balsam	*Populus balsamifera* L.
spruce, black	*Picea mariana* (Miller) B.S.P.
spruce, red	*Picea rubens* Sarg.
spruce, white	*Picea glauca* (Moench) Voss
tamarack	*Larix laricina* (Du Roi) K. Koch
	Other Plants
blueberry	*Vaccinium* spp.
broadleaf	*Spartina pectinata* Link
browntop	*Agrostis repens* Sibth.
bunchberry	*Cornus canadensis* L.
clubmoss, bristly	*Lycopodium annotinum* L.
clubmoss, shining	*Lycopodium lucidulum* Michaux
cord-grass	*Spartina alterniflora* Loisel.
cotton-grass	*Eriophorum* spp.
fern, wood	*Dryopteris spinulosa* (O.F. Muell.) Watt
foxberry	*Vaccinium vitis-idaea* L.
glasswort	*Salicornia europaea* L.
goldthread	*Coptis groenlandica* (Oeder) Fern.
grass, black	*Juncus Gerardii* Loisel.
grass, poverty oat	*Danthonia spicata* (L.) Beauv.
grass, quack	*Agropyron repens* (L.) Beauv.
hazelnut, beaked	*Corylus cornuta* Marsh.
hobblebush	*Viburnum alnifolium* Marsh.
miterwort, naked	*Mitella nuda* L.
moss, hypnum	*Hypnum* spp.
moss, Schreber's	*Pleurozium schreberi* (Brid.) Mitt
moss, sphagnum	*Sphagnum* spp.
pitcher-plant	*Sarracenia purpurea* L.
raspberry, wild	*Rubus strigosus* Michaux
rhodora	*Rhododendron canadense* (L.) Torrey
sand spurrey	*Spergularia marina* (L.) Griseb.
sea-rocket	*Cakile edentula* (Bigel.) Hooker
sheep-laurel	*Kalmia angustifolia* L.
sweet-fern	*Comptonia peregrina* (L.) Coulter
tea, Labrador	*Ledum groenlandicum* Oeder
wintergreen	*Gaultheria procumbens* L.
witherod	*Viburnum cassinoides* L.
wood-sorrell	*Oxalis montana* Raf.

APPENDIX 1

Guide to Determination of Soil Texture

This guide is included to aid in the more accurate description of soils. It refers to the three primary particle sizes of soil; sand consists of particles 2 to 0.05 mm in diameter, silt 0.05 to 0.002 mm, and clay less than 0.002 mm. The sand may be further subdivided into five grades from very coarse to very fine. The actual percentages of these size fractions defining a given texture are shown in Figure 23. Gravelly is added to the textural class name when particles 2 mm to 7.6 cm (3 inches) in diameter occupy 20–50% by volume; very gravelly is used when this material exceeds 50%.

The textures listed below are in order from coarse (sand) to fine (clay).

Sand consists mostly of coarse and fine sand and so little clay that it is loose when dry and not sticky at all when wet. When rubbed it leaves no film on the fingers.

Loamy sand consists mostly of sand but with sufficient clay to give slight plasticity and cohesion when very moist. It leaves a slight film of fine materials on the fingers when rubbed.

Sandy loam is a soil material in which the sand fraction is still quite obvious and grains can be seen and felt readily. It molds readily when sufficiently moist, but in most cases does not stick appreciably to the fingers. Threads do not form easily.

Loam is a soil material in which the fractions are so blended that it molds readily when sufficiently moist and sticks to the fingers to some extent. It can be molded with difficulty into threads but will not bend into a small ring.

Silt loam is moderately plastic without being very sticky and the smooth soapy feel of the silt is the main feature. Dry aggregates appear cloddy but crush easily into floury powder. Threads are difficult to form.

Sandy clay loam contains sufficient clay to be distinctly sticky when moist, but the sand fraction is still an obvious feature. When moist it can be rolled into a thread that can just be bent into a small ring without breaking. Hard clods form when it is dry.

Clay loam is distinctly sticky when sufficiently moist, and the presence of sand fractions can only be detected with care. It can be formed into threads and rings when moist. When dry it is hard.

Silty clay loam contains quite subordinate amounts of sand and sufficient silt to give a rather smooth soapy feel. It is less sticky than silty clay or clay loam.

Silt is soil in which the smooth, soapy feel of silt is dominant.

Sandy clay is plastic and sticky when moistened sufficiently, but the sand fraction is still an obvious feature. Clay and sand are dominant, and the intermediate grades of silt and very fine sand are less apparent.

Silty clay is composed almost entirely of very fine material, but the smooth soapy feel of the silt fraction modifies to some extent the stickiness of the clay.

Clay is plastic and usually extremely sticky when moistened sufficiently; it gives a polished surface on rubbing. When moist it can easily be rolled into threads that do not break on bending. It molds into any shape and takes clear fingerprints. A small proportion of sand may be detected with care.

SOILS OF CUMBERLAND COUNTY
NOVA SCOTIA

Appendix 2

ANALYTICAL DATA
ENGINEERING DATA

Analytical data

Hor.	Depth inches	pH H_2O	Loss on ignition %	Lime req'd. tons/ac	Total N %	Total SiO_2 %	Total R_2O_3 %	Total CaO %	Avail. P lb/ac	NH_4OAc extr. cations, meq/100 g H	Ca	Mg	K	Na	Gravel %	Sand 2.0 to 0.05 mm %	Silt %	Clay %
									Acadia Series *									
Ap	0-6	4.8	8.0	5.6	0.24	64.4	23.7	0.57	80	9.57	2.78	3.28	0.32	0.67	0	15.2	60.2	24.6
Cg	6-12	5.6	4.9	3.9	0.13	66.0	29.5	0.56	158	5.06	2.64	5.55	0.21	.1.47	0	12.2	57.2	30.6
Cg	12-18	7.1	2.7	0.0	0.09	67.6	26.1	0.67	297	0.00	2.53	6.33	0.29	3.06	0	13.4	60.2	26.4
Cg	18-30	7.9	2.8	0.0	0.06	69.7	25.1	0.70	317	0.00	1.94	5.28	0.56	4.09	0	13.4	58.6	28.0

* This site is located 0.5 mile from that described in the report.

Hor.	Depth inches	pH H_2O	pH $CaCl_2$	Loss on ignition %	Extractable with Oxalate Fe %	Oxalate Al %	Dithionite Fe %	Dithionite Al %	Exchangeable H	Exchangeable Al	NH_4OAc extr. cations, meq/100 Ca	Mg	K	CEC	Perm. charge CEC	Base sat. %	Gravel %	Sand 2.0 to 0.25 mm %	Sand 0.25 to 0.05 mm %	Silt %	Clay %
											Cobequid Series										
LFH	2-0	4.1	4.5						3.8	4.2	6.8	0.03	0.09	14.9	12.0	93					
Ae	0-1	3.8	3.7	6.0	0.27	0.15	1.1	0.34	6.2	5.2	0.14	0.07	0.15	11.8	4.37	81	12.3	7.9	36.4	50.5	5.2
Bhf	1-5	4.5	4.3	23.7	3.0	3.9	4.2	3.2							2.80	53	3.2	8.0	41.8	43.2	7.0
Bfh	5-13	4.9	4.5	6.9	0.67	2.0	1.2	1.6	2.2	0.80	0.15	0.11	0.05	3.3	0.93	69	10.7	16.7	52.3	26.5	4.5
BC	13-19	5.3	4.2	2.2	0.27	1.0	0.65	0.68	1.2	0.40	0.04	0.05	0.06	1.8	0.54	100	8.3	23.2	51.1	23.5	2.2
C	19-32	5.3	4.7	1.9	0.29	0.76	0.54	0.52	2.2	0.40	0.04	0.10	0.08	2.8	0.54	100	28.2	31.8	48.3	18.2	1.7
Ah*	0-3	4.3	4.4	22.3	1.6	0.68	2.4	0.72	6.6	6.8	0.29	0.23	0.08	14.0	9.77	86	8.7	10.0	35.5	40.9	13.6
											Hansford Series										
LFH	3-0	4.3	3.8	62.3					6.60	3.20	6.99	2.50	2.05	21.3	13.6	98					
Ae	0-4	4.4	3.8	0.3	0.01	0.06	0.08	0.07	3.00	5.80	0.34	0.22	0.07	9.4	2.06	47	0.0	7.0	74.4	18.4	0.2
Bfh	4-8	4.7	4.2	7.1	0.88	1.82	2.40	1.43	2.60	5.60	0.38	0.21	0.11	8.9	2.67	45	4.7	13.6	78.4	7.7	0.3
Bf	8-16	5.3	5.0	4.2	0.66	1.74	1.66	0.96	1.50	1.00	0.17	0.07	0.10	2.8	0.87	100	5.0	7.5	74.3	12.4	5.8
BC	16-19	5.6	5.4	0.4	0.18	0.20	0.78	0.15	1.80	0.60	0.85	0.21	0.10	3.6	1.51	100	14.9	17.5	72.3	9.5	0.7
IIC	19-26	6.0	5.6	0.7	0.37	0.22	2.50	0.18	1.00	0.80	4.12	0.62	0.12	6.7	5.23	100	61.5	7.7	46.6	36.4	9.3
IIC	26-34	6.2	6.1	0.3	0.12	0.11	1.39	0.10	1.80	0.40	2.65	0.37	0.10	5.3	3.05	100	51.4	30.7	32.9	29.1	7.3

*Ah sample taken 50 ft from the site.

Masstown Series

LFH	3-0	4.3	3.8	50.2					5.80	2.40	6.99	0.25	1.37	16.8	22.6	99				
Aeg	0-9	4.7	5.0	2.1	0.29	0.26	0.74	0.31	3.00	3.00	0.10	0.12	0.07	6.3	3.80	39	3.2	8.0	42.6	40.4	9.0
Bg	9-13	4.9	4.3	1.2	0.34	0.33	1.68	0.38	2.40	1.00	0.08	0.07	0.08	3.6	1.18	51	1.5	8.0	49.3	35.5	7.2
Bxg	13-20	5.1	4.2	0.7	0.28	0.19	1.32	0.16	1.80	2.00	0.38	0.31	0.10	4.6	2.44	70	3.8	9.2	43.7	39.0	8.1
Bxj	20-29	5.1	4.6	0.5	0.10	0.12	0.98	0.08	2.20	3.60	0.61	0.50	0.10	7.0	2.28	100	24.6	11.2	46.7	36.3	5.8
C	29-40	5.3	5.0	0.3	0.15	0.12	0.98	0.10	2.00	0.80	0.57	0.45	0.10	3.9	2.04	100	20.7	10.8	50.5	33.3	5.4

Rodney Series A*

LFH	4-0	4.9	4.0	70.5					4.00	13.60	0.84	0.48	0.93	19.9	10.43	71				
Ae	0-3	4.3	3.6	3.5	0.08	0.07	0.77	0.12	0.56	0.68	0.34	0.26	0.14	2.0	4.23	57	16.9	10.1	35.6	44.2	10.1
Bfh	3-9	4.6	4.2	5.3	0.93	0.42	2.40	0.51	2.84	0.24	0.12	0.12	0.15	3.5	4.12	49	41.3	9.8	25.9	47.0	17.3
BC	9-15	4.7	4.4	2.5	0.40	0.28	1.50	0.32	0.52	0.16	0.07	0.07	0.08	0.9	2.40	73	28.5	15.2	34.0	42.5	8.3
BC	15-23	4.9	4.1	0.9	0.26	0.16	1.50	0.17	0.52	0.76	0.08	0.11	0.09	1.6	2.47	46	28.6	13.7	34.4	43.1	8.8
C	23-36	5.1	4.1	0.7	0.20	0.10	1.30	0.08	0.64	0.92	0.15	0.24	0.11	2.1	2.51	69	27.6	16.1	34.9	43.4	5.6

Rodney Series B

LFH	2-0	3.8	3.0	79.9					14.80	3.60	0.82	0.17	0.06	19.5	18.1	98				
Ae	0-3	4.1	4.0	1.9	0.05	0.12	1.04	0.14	5.00	1.60	1.71	0.48	0.10	8.9	3.24	52	52.3	23.8	30.5	41.7	4.0
Bhf	3-7	4.6	4.4	12.4	1.21	2.20	2.46	2.08	2.60	4.40	1.32	0.52	0.27	9.1	2.38	49	28.8	25.4	32.6	35.6	6.4
Bfh	7-13	4.8	4.4	7.7	0.71	1.04	1.88	1.24	2.20	4.20	0.04	0.03	0.10	6.6	2.22	52	26.7	22.3	30.4	42.2	5.1
Bfj	13-23	4.9	4.4	1.9	0.13	0.59	1.40	0.46	2.20	2.20	0.04	0.03	0.14	4.6	1.05	51	20.2	18.9	32.8	43.6	4.7
Bx	23-30	5.0	4.7	1.4	0.14	0.54	1.38	0.43	2.40	1.40	0.20	0.10	0.10	4.2	0.74	81	21.9	21.3	37.5	36.8	4.4
C	30-36	5.0	4.7	1.1	0.11	0.48	1.48	0.38	2.60	1.60					0.89	75	27.9	23.3	29.5	41.6	5.6

Springhill Series

LFH	4-0	3.8	3.1						8.40	7.80	0.62	0.95	0.58	18.3	8.50	64				
Ae	0-3	4.4	3.7	1.5	0.07	0.08	0.12	0.05	0.96	3.12	0.02	0.07	0.08	4.2	3.95	36	4.3	7.5	44.8	43.1	4.6
Aeg	3-7	4.7	3.9	2.3	0.16	0.18	0.30	0.18	0.80	2.52	T	0.09	0.09	3.5	3.86	43	21.4	8.8	40.9	48.5	1.8
Bg	8-10	5.0	4.3	2.4	0.43	0.29	1.00	0.30	0.64	1.08	0.04	0.04	0.08	1.9	2.20	49	24.4	12.8	37.9	43.9	5.4
Bx	10-17	4.8	4.2	0.6	0.21	0.13	0.84	0.14	0.60	1.40	0.04	0.07	0.07	2.2	1.77	60	13.8	10.7	40.7	42.6	6.0
Bx	17-26	4.8	4.4	0.6	0.18	0.10	0.77	0.08	0.64	1.12	0.20	0.15	0.08	2.2	1.83	83	21.8	10.2	46.5	38.8	4.5
C	26-40	5.3	4.7	0.6	0.16	0.07	0.82	0.06	0.56	0.64	0.61	0.38	0.09	2.3	2.18	94	34.0	11.9	45.0	39.4	3.7

*This site is representative of those soils formerly mapped in the Southampton Series, which is no longer recognized as a separate series.

Analytical data (cont'd)

Hor.	Depth inches	pH H_2O	pH $CaCl_2$	Loss on ignition %	Extractable with Oxalate Fe %	Oxalate Al %	Dithionite Fe %	Dithionite Al %	Exchangeable H	Exchangeable Al	NH_4OAc extr. cations, meq/100 g Ca	Mg	K	CEC	Perm. charge CEC	Base sat. %	Gravel %	Sand 2.0 to 0.25 mm	Sand 0.25 to 0.05 mm	Silt %	Clay %
											Westbrook Series										
LFH	5-0	4.5	3.8	67.6					6.60	2.80	7.00	2.50	2.05	21.0	27.5	99					
Ae	0-3	3.9	3.7	0.8	0.03	0.05	0.86	0.06	0.44	0.96	0.15	0.09	0.08	1.7	2.31	46	17.2	30.4	33.6	33.6	2.4
Bfh	3-13	5.2	4.5	9.0	0.81	2.70	3.20	1.70	0.36	0.64	0.20	0.08	0.16	1.4	1.46	78	21.9	29.5	35.6	27.0	7.9
Bf	13-24	5.3	4.8	1.9	0.33	0.79	3.00	0.66	0.52	0.20	0.04	0.04	0.10	0.9	0.67	100	47.6	37.1	21.7	36.8	4.4
C	24-36	5.1	4.0	1.3	0.10	0.22	4.30	0.17	0.64	3.04	0.32	0.37	0.16	4.5	5.95	45	15.0	24.2	27.8	35.6	12.4
C	36-44	5.1	4.0	1.2	0.47	0.20	4.70	0.14	0.88	2.64	0.38	0.43	0.16	4.5	5.69	48	10.6	27.3	25.1	33.4	14.2
											Wyvern Series										
LFH	2.5-0	4.1	3.8	62.4					17.20	10.60	6.84	2.22	1.59	38.5	18.6	99					
Ae	0-1.5	3.9	3.7	2.8	0.10	0.05	0.64	0.15	4.60	2.20	0.34	0.12	0.12	7.4	2.14	66	14.5	16.5	35.6	41.8	6.1
Bhf	1.5-5.5	4.8	4.2	17.9	2.00	3.16	2.79	2.30	7.40	0.40	0.04	0.03	0.07	7.9	4.80	59	24.1	23.8	38.3	32.6	5.3
Bhf	5.5-10	4.6	4.3	13.2	1.21	2.50	1.78	2.33	4.00	0.40	0.23	0.09	0.11	4.8	2.08	45	33.6	27.0	34.1	34.3	4.6
Bf	10-20	4.9	4.5	4.7	0.50	1.23	1.02	1.16	3.40	2.80	0.19	0.05	0.08	6.5	1.20	73	19.4	24.0	35.3	39.2	1.5
BC	20-27	5.0	4.9	1.6	0.28	0.82	0.91	0.63	2.40	1.80	0.08	0.05	0.12	4.5	0.67	100	15.8	23.8	30.8	40.2	5.2
C	27-36	5.0	4.8	1.6	0.19	0.72	0.76	0.46	3.00	2.00	0.08	0.03	0.10	5.2	0.67	100	57.6	46.4	28.2	21.3	4.1
											Debert Series										
LFH	3-0	4.0	3.2	65.1					14.00	7.20	6.99	2.22	1.22	31.6	18.9	92					
Aeg	0-9	4.2	3.7	0.9	0.03	0.22	0.09	0.20	1.48	5.00	0.23	0.12	0.04	6.8	6.09	21	6.9	7.5	47.0	37.9	7.6
Bfg	9-11	4.5	4.1	3.1	0.38	0.76	1.08	0.78	0.28	1.76	0.12	0.74	0.07	3.0	3.06	35	23.6	9.0	46.6	42.7	1.7
Bx	11-16	5.0	4.5	0.5	0.05	0.10	1.04	0.10	0.44	0.28	2.29	0.43	0.08	3.5	3.22	100	9.5	10.0	47.1	36.0	6.9
Bx	16-22	4.7	4.2	0.3	0.11	0.20	1.20	0.18	0.72	1.40	0.67	0.20	0.09	3.1	2.75	61	8.4	8.3	46.9	36.4	8.4
C	22-36	5.7	5.2	0.1	0.06	0.09	0.96	0.09			2.65	0.31	0.10		3.15	100	6.0	7.6	47.4	38.6	6.4

Tormentine Series

LFH	4-0	3.6	3.2	55.1					12.80	5.80	7.14	2.50	1.16	29.4	18.7	91				
Ae	0-4	3.9	3.4	1.3	0.05	0.14	0.34	0.13	4.20	0	0.26	0.19	0.06	4.7	4.55	31	2.0	6.8	46.3	41.2	5.7
Bfh	4-12	4.7	4.3	6.2	0.60	0.91	1.36	1.07	1.52	0	0.55	0.14	0.16	2.4	3.22	42	12.8	8.3	44.9	38.4	8.4
Bxj	12-22	6.0	5.4	0.1	0.09	0.18	0.98	0.15	0.48	0	1.31	0.27	0.11	2.2	2.01	100	10.9	2.5	52.4	39.6	5.5
C	22-37	6.8	6.3	0.3	0.07	0.10	1.36	0.09	0.32	0	3.69	0.31	0.11	4.4	3.48	100	7.7	6.5	45.7	35.3	12.5
C	37-48	7.1	6.6	0.3	0.09	0.08	1.42	0.08	0.32	0	4.42	0.20	0.11	5.1	4.22	100	8.7	7.6	43.5	37.2	11.7

Hor.	Depth inches	Core depth inches	Pore space <0.05 mm %	Pore space >0.05 mm %	Pore space Total %	Bulk density* g/cm^3	Shrinkage on drying vol %	Hydraulic conductivity inches/hr
			Debert Series					
Aeg	0-9	1-4	29.3	8.4	37.7	1.50	1.8	0.25
Bx	16-22	17-20	24.3	6.7	31.0	1.85	0	0.01
			Tormentine Series					
Ae	0-4	0.5-3.5	32.7	10.1	42.8	1.38	4.5	1.05
Bfh	4-12	4-7	38.2	12.9	51.1	0.87	7.7	11.97
Bxj	12-22	17-20	23.5	6.3	29.8	1.84	0	0.18
C	22-37	34-37	25.1	5.9	31.0	1.88	0	0.40
C	37-48	42-45	25.6	5.3	30.9	1.86	0	0.58

*Bulk density of fine earth (< 2 mm) determined on cores.

Analytical data (concl'd)

Hor.	Depth inches	pH $CaCl_2$	Organic C %	Extractable with Oxalate Fe %	Oxalate Al %	Dithionite Fe %	Dithionite Al %	Total Fe %	Total Mn %	Total Ti %	Perm. charge CEC	Base sat. %	$CaCO_3$ equiv. % as calcite	$CaCO_3$ equiv. % as dolomite	Sand 2.0 to 0.25 mm	Sand 0.25 to 0.05 mm	Silt %	Clay %	Fine clay %	Bulk density g/cm^3
										Joggins Series										
LFH	4-0	3.0	37																	
Aeg1	0-3.5	3.1	1.1	0.06	0.18	0.14	0.17	0.50	0.008	0.55	5.3	41			5.0	33	43	15	4.5	1.7
Aeg2	3.5-5.5	3.5	0.5	0.27	0.18	1.2	0.21				4.2	52			11.0	47	28	14	4.8	1.8
Btg	5.5-10	3.6	0.2	0.50	0.22	2.1	0.26	3.4	0.056	0.46	4.8	69			8.0	32	37	23	7.1	
IIBCg	10-15	4.2	0.5	0.26	0.19	1.8	0.28				11.2	100			2.7	13	48	36	11.0	2.0
IIC	15-28	5.5	0.6	0.19	0.14	1.9	0.24	3.6	0.076	0.59	15.0	100			2.9	12	47	38	10.0	2.0
IICk	28-34	6.3	0.6	0.16	0.13	1.8	0.23	4.3	0.105	0.70		100	0.0	0.2	3.0	11	51	35	9.5	2.0

Data provided by J. A. McKeague, Soil Research Institute, Ottawa.

Hor.	Depth inches	pH H_2O	pH $CaCl_2$	Loss on ignition %	Extractable with Oxalate Fe %	Oxalate Al %	Dithionite Fe %	Dithionite Al %	Exchangeable H	Exchangeable Al	NH_4OAc extr. cations, meq/100 g Ca	Mg	K	CEC	Perm. charge CEC	Base sat. %	Gravel %	Sand 2.0 to 0.25 mm	Sand 0.25 to 0.05 mm	Silt %	Clay %
											Kirkhill Series										
LFH	3-0	4.5	3.8	50.6					9.80	8.80	4.27	1.65	1.36	25.9	17.0	96					
Ae	0-1	4.1	3.7	1.0	0.23	0.06	0.72	0.10	1.04	1.96	0.15	0.15	0.10	3.4	2.90	60	10.9	12.2	15.4	53.9	18.5
Bhf	1-4	4.2	3.7	13.6	5.20	0.90	7.30	1.60	1.64	2.56	0.34	0.26	0.16	5.0	6.32	57	21.7	34.3	16.8	36.2	12.7
Bfh	4-8	4.1	4.0	9.6	3.60	0.72	5.40	1.20	1.24	2.12	0.20	0.21	0.14	3.9	4.25	58	37.5	33.0	18.3	25.4	23.3
Bf	8-19	5.2	4.5	4.6	2.40	0.80	3.80	1.70	0.52	0.72	T	0.35	0.09	1.7	1.60	76	43.0	50.5	16.4	25.2	7.9
C	19-32	5.0	4.6	1.0	0.48	0.39	0.84	0.38	0.89	0.44	T	0.03	0.09	1.5	1.11	100	33.2	57.3	20.9	19.7	2.1
											Pugwash Series										
Ap	0-6	4.6	4.4	6.1	0.52	0.45	0.62	0.62	2.80	2.00	0.34	0.11	0.08	5.3	4.07	72	15.0	12.7	37.9	34.7	14.7
Bf*	6-13	5.0	4.3	3.1	0.58	0.67	1.38	0.56							3.05	46	17.4	11.0	37.9	35.0	16.1
Bxj	13-19	5.0	4.3	1.5	0.39	0.44	1.48	0.38	1.80	3.20	0.39	0.14	0.09	5.6	2.63	59	13.1	9.7	34.3	37.0	19.0
Bx	19-23	5.0	4.1	1.2	0.39	0.34	1.63	0.24	2.60	3.60	0.54	0.19	0.15	7.1	3.40	50	13.3	8.4	31.7	40.1	19.8
C	23-32	4.8	4.2	1.1	0.37	0.22	1.66	0.17	3.00	6.40	1.51	0.49	0.16	11.6	4.99	69	7.8	10.0	32.3	37.8	19.9

*It is presumed that the upper portion of the horizon meets the criteria for a Bf designation.

Hor.	Depth inches	Atterberg limits (% water) LPL	UPL	Plasticity number
		Kirkhill Series		
Ae	0-1	29.6	35.8	6.2
Bfh	4-8	61.7	67.2	5.5

Hor.	Depth inches	Atterberg limits (% water) LPL	UPL	Plasticity number
		Pugwash Series		
Ap	0-6	35.0	37.0	2.0
Bf	6-13	25.2	28.7	3.6
Bxj	13-19	19.9	22.6	2.7
Bx	19-23	16.8	22.1	5.3
C	23-32	13.5	22.4	8.9

Hor.	Depth inches	pH H_2O	pH $CaCl_2$	Organic C %	Extractable with Oxalate Fe %	Oxalate Al %	Dithionite Fe %	Dithionite Al %	Perm. charge C.E.C.	Base sat. %	Sand %	Silt %	Clay %	Fine clay %	Bulk density g/cm^3
					Queens Series										
Ahe	0-1.5		3.4	3.1	0.18	0.20	0.34	0.35	3.89	89					
Ahe	1.5-4	4.0	3.6	2.1	0.21	0.17	0.37	0.24	3.93	71	47	41	12	3	1.2
Aeg1	4-7	4.3	3.8	0.5	0.10	0.15	0.27	0.13	3.44	42	48	42	10	2	1.5
Aeg2	7-10		3.9	0.4	0.33	0.24	1.2	0.26	2.46	62	52	36	12	3	1.6
Btjg1	10-13	4.4	3.9	0.4	0.36	0.26	1.7	0.34	3.74	79	44	40	16	5	1.7
Btjg2	13-17	4.7	4.2	0.2	0.27	0.17	1.5	0.19	3.42	96	55	34	11	4	1.7
Bt	19-21	5.7	5.0	0.1	0.19	0.10	1.4	0.15	5.20	100	58	29	13	6	1.9
BC	21-26		5.3	0.1	0.13	0.09	1.5	0.08	6.43	100	44	41	15	6	2.0
C	26-32		6.1	0.1	0.10	0.09	1.6	0.09	6.70	100	44	41	15	5	2.0
C	32-36	6.6	6.1	0.1	0.08	0.08	1.6	0.08	6.50	100	37	45	18	6	2.0
Ck	52-60		7.4						5.83	100	36	47	17	5	

Data of J. A. McKeague, Soil Research Institute, Ottawa. This is soil no. 7 in McKeague et al. (23, 24, 25).

ENGINEERING DATA

The engineering data in this section are from analyses carried out in the materials laboratory of the Nova Scotia Department of Highways. The samples were taken from locations different from those used for the foregoing *General Analytical Data*. At each location a single sample was taken from the C horizon or parent material at a depth of 3 to 4 ft, except where otherwise indicated.

The determination of Atterberg limits and washed sieve analysis followed standard A.S.T.M. procedures (American Society for Testing and Materials. 1964. Procedures for testing soils. A.S.T.M. Standards, Vol 11, 1968). The petrographic number, a method of appraising and comparing the quality of coarse aggregates for use as highway construction material, was determined by unpublished methods adapted by the Nova Scotia Department of Highways from those of the Ontario Department of Highways.

Some of the soil series have developed from the same parent material as others. This means that the data for Hebert soils apply equally to the Millar soils, and those for Pugwash and Tormentine cover the Springhill and Economy soils. The data for Queens soils cover the Falmouth and Kingsville soils, and those for Cumberland cover the Bridgeville soils. Diligence and Joggins soils can also be considered as broadly similar.

Fig. 24. Locations of soil samples taken for engineering analyses.

Table 27. Locations of samples used for engineering analysis

Sample no.	Soil series	Location
1	Acadia	Nappan River dykeland, Upper Nappan
2	Cobequid	1 mile S of Halfway River Station, E side of Parrsboro Valley
3	Cobequid	0.5 mile N of Folly Lake, E side of Highway 104
4	Cumberland	S side of Westchester Station
5	Cumberland	0.5 mile S of Collingwood Corner, E side of road to Wyvern
6	Diligence	1.5 miles S of Parrsboro beside road to Union Valley
7	Diligence	2 miles E of Union Valley, near Parrsboro
8	Hansford	1.5 miles N of Conns Mills on roadside
9	Hansford	1 mile SE of Conns Mills
10	Hebert	Halfway River Station gravel pit
11	Hebert	S side of Westchester Station
12	Hebert	1 mile NE of Jackson (Millvale), near Collingwood
13	Hebert	Gravel pit, N end of Folly Lake
14, 15	Hebert	Wentworth Valley, 0.5 mile S of motel
16	Hebert	West Advocate, 200 yd N of road junction
17, 18	Hebert	East Advocate gravel pit
19, 20	Hebert	East Advocate gravel pit 0.5 mile E of village
21, 22	Hebert	Kirkhill village near Parrsboro
23	Hebert	Gravel pit 2 miles NE of Parrsboro
24	Hebert	5 miles S of River Hebert on Boars Back road
25	Hebert	1 mile E of Malagash on road to Malagash Point
26	Hebert	Hansford village
27	Joggins	0.5 mile W of River Hebert
28	Kirkhill	2 miles N of Parrsboro
29	Kirkhill	2 miles S of Parrsboro, near Partridge Island
30	Pugwash	2 miles S of Mount Pleasant on road to Oxford
31	Pugwash	3 miles N of Springhill Junction
32	Queens	4 miles SE of Wallace on Highway 6
33	Queens	Fox Harbour
34	Queens	4 miles SW of Pugwash on road to Conns Mills
35	Queens	2.5 miles S of Upper Nappan on road to Springhill
36	Rodney	1 mile E of Rodney
37	Rodney	Leamington
38	Rodney	East Mapleton
39	Rodney	3 miles S of Athol on road to Leamington
40	Shulie	Lower River Hebert
41	Shulie	2 miles SW of Barronsfield on road to River Hebert
42	Shulie	2 miles S of Maccan on road to Athol
43	Shulie	1 mile N of Athol
44	Tormentine	2 miles NE of Shinimicas Bridge
45	Westbrook	3 miles N of River Philip Centre
46	Westbrook	1.5 miles NE of Halfway River Station
47	Wyvern	2 miles SW of Westchester Station
48	Conglomerate bedrock (weathered)	1 mile N of Malagash

Engineering data

Sample no	1	2	3	4	5	6	7	8	9
Soil series	Acadia	Cobequid		Cumberland		Diligence		Hansford	
Liquid limit %	31.2	33.9	33.9			73.4	40.7	21.3	18.6
Plastic limit %	27.7	NP	NP	NP	NP	48.4	27.2	NP	NP
Plasticity index	3.5	NP	NP	NP	NP	25.0	13.5	NP	NP
USCS	ML	GW-GM	GM	GW	GP	SM	SM	GM	SM
Petrographic no		100	100	100	120			485	492
Percentage passing sieve: 2 in		95	87	71	62			100	100
1½ in		92	74	63	61	100		98	92
1 in		87	61	57	57	97	100	87	86
¾ in		81	56	50	52	96	97	79	82
½ in		71	51	42	47	95	87	70	77
⅜ in		64	48	36	45	93	80	65	72
no 4	100	47	42	25	36	83	67	55	64
no 8	98	31	38	15	27	74	59	48	59
no 16	96	21	35	8.2	19	66	52	45	56
no 30	95	15	33	4.8	13	60	43	41	51
no 50	94	11	29	2.7	8.0	53	37	31	34
no 100	93	8.0	24	1.7	5.6	48	33	23	26
no 200	93	6.3	19	1.2	4.2	45	31	21	23

Engineering data (cont'd)

Sample no	10	11	12	13	14	15	16	17	18	19
Soil series	Hebert (20 ft)	Hebert (30 ft)	Hebert (9 ft)	Hebert (35 ft)	Hebert	Hebert (7 ft)	Hebert (8 ft)	Hebert	Hebert (12 ft)	Hebert (12 ft)
Liquid limit %	27.9									
Plastic limit %	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
Plasticity index	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
USCS	SW	SW	GW	GW	GW	GW	SW	GW	GW	GW
Petrographic no	419	218	100	110	156	118	130	165	122	125
Percentage passing sieve: 2 in			81	67	74	79	85	83	73	75
1½ in	100		74	51	50	61	81	83	61	69
1 in	95		68	41	37	51	77	83	51	55
¾ in	93	96	61	36	29	47	74	73	50	51
½ in	89	94	52	33	27	37	74	58	47	43
⅜ in	85	87	48	29	24	31	72	48	43	36
no 4	76	66	39	26	17	20	66	32	30	27
no 8	68	37	27	24	11	15	53	19	22	21
no 16	57	17	19	20	7.2	10	26	11	15	15
no 30	29	9.6	14	15	4.7	7.8	13	8.0	9.6	9.8
no 50	13	7.4	9.9	10	3.0	5.7	7.9	2.9	2.4	7.2
no 100	6.3	6.8	7.7	7.4	2.1	4.3	6.3	2.1	1.1	4.5
no 200	4.1	6.1	6.6	5.9	1.7	3.7	5.1	1.7	0.9	2.1

Engineering data (cont'd)

Sample no		20	21	22	23	24	25	26	27	28	29
Soil series		Hebert		Hebert (33 ft)	Hebert (40 ft)	Hebert (30 ft)	Hebert (15 ft)	Hebert	Joggins	Kirkhill	
Liquid limit %									25.7	20.7	26.2
Plastic limit %		NP	NP	NP	NP	NP	NP	NP	18.9	NP	24.5
Plasticity index		NP	NP	NP	NP	NP	NP	NP	6.8	NP	1.7
USCS		GP	GW	GW-SW	GW	GW-GM	SM	GM	SC	SM	GP-GM
Petrographic no		165	207	185	206	336	769	458	413	600	1000
Percentage passing sieve	2 in		63		90	44		92			
	1½ in		57		85	34	90	71	100	100	100
	1 in	95	57	95	73	25	90	64	94	99	86
	¾ in	84	51	83	62	22	84	59	89	98	78
	½ in	52	41	72	50	21	79	56	80	96	68
	⅜ in	30	37	65	43	19	75	54	73	92	60
	no 4	12	26	50	31	16	63	49	61	75	41
	no 8	7.9	17	39	23	13	53	44	52	54	28
	no 16	3.2	11	24	17	10	47	41	45	36	20
	no 30	1.7	5.4	12	10.8	8.3	43	37	37	25	16
	no 50	1.5	1.3	5.0	4.5	7.3	36	29	28	18	12
	no 100	1.4	0.6	3.2	2.3	6.4	30	23	23	14	10
	no 200	1.3	0.5	2.8	1.6	6.1	26	21	22	11	8.8

Engineering data (cont'd)

Sample no	30	31	32	33	34	35	36	37	38	39
Soil series	Pugwash		Queens				Rodney			
Liquid limit %	19.2	26.3	29.2	21.8	21.6	23.2	26.4	18.3	30.6	18.0
Plastic limit %	NP	21.2	18.6	7.7	18.8	22.2	NP	NP	NP	NP
Plasticity index	NP	5.1	10.6	4.1	2.8	1.0	NP	NP	NP	NP
USCS	SM	SM	SC	CL	CL	SM	GP	GM	SM	SM
Petrographic no	554	490	439	676	651	459	327	439	414	361
Percentage passing sieve: 2 in	93	100	100			100	87	100	96	94
1½ in	86	91	98	100		96	78	88	89	91
1 in	70	87	96	98	100	92	65	80	86	86
¾ in	75	86	95	95	98	90	60	74	83	84
½ in	71	83	90	91	97	90	53	66	77	81
⅜ in	66	82	89	89	96	88	47	61	72	79
no 4	58	76	82	84	94	86	38	52	59	74
no 8	51	69	73	81	91	83	30	43	48	69
no 16	37	64	65	79	89	79	21	37	38	66
no 30	20	59	59	76	87	74	13	32	29	62
no 50	14	51	52	71	82	64	7.2	25	20	44
no 100	13	44	47	64	75	54	4.6	19	14	38
no 200	12	40	45	62	71	50	3.4	17	12	33

Engineering data (concl'd)

Sample no	40	41	42	43	44	45	46	47	48
Soil series	Shulie				Tormentine	Westbrook		Wyvern	Conglomerate bedrock (8 ft)
Liquid limit %	16.8	23.6	20.4		16.3	25.8	22.7	24	
Plastic limit %	NP	NP	NP	NP	NP	22.1	NP	NP	NP
Plasticity index	NP	NP	NP	NP	NP	3.7	NP	NP	NP
USCS	SM	GM	SM	SM	SM	SM	SM	GM	SM
Petrographic no	354	353	345	486	799	417	376	111	599
Percentage passing sieve: 2 in	86	90	100		100	100	100	84	
1½ in	86	81	92		93	97	98	82	
1 in	82	69	86	100	87	92	97	75	91
¾ in	79	65	84	97	83	89	94	65	86
½ in	76	61	80	96	79	82	86	57	77
⅜ in	74	58	76	95	77	78	80	49	71
no 4	70	53	68	81	73	67	64	36	60
no 8	67	48	60	72	71	56	48	27	53
no 16	65	46	47	69	70	49	37	22	49
no 30	62	44	37	67	68	44	31	19	44
no 50	48	38	29	62	55	39	26	17	38
no 100	41	30	26	53	43	34	17	15	31
no 200	39	26	25	49	39	29	11	13	27

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